SCIENCE

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*A NEW GAS.**

THE purpose of this purely preliminary paper is to announce the discovery of a new gas, presumably elementary, and possessed of some extraordinary properties. It is a constituent of the atmosphere and is occluded by many substances. Its chief characteristic thus far ascertained is enormous heat conductivity at low pressures. In order to appreciate this phenomenon it is necessary to consider the heat conductivity of some of the well-known gases.

A year ago I had the honor to read before this Section a paper on the transmission of heat by gases, illustrated by numerous curve sheets showing the heat conductivity of several gases at all pressures from atmospheric down to the best vacuum obtainable; also an allied paper on the measurement of small gaseous pressures. Abstracts of these papers appear in the current volume of Transactions, and their full text may be found in the *Philosophical Magazine* for January, 1898, and November, 1897, respectively.

The apparatus used for the described experiments in heat transmission consisted in part of a long-stemmed thermometer hanging in a long-necked glass bulb, the bulb of the thermometer being in the center of the glass bulb. Two bulbs were used for different experiments; the larger one 112 mm. in diameter, the smaller one only 20 mm. A tank of water and crushed ice under the bulb was adapted to be raised when desired, so as to immerse the bulb in the cold mixture. The neck of the bulb was connected with an air pump capable of reducing the internal pressure to a very small fraction of a millionth of atmospheric pressure; also with an elaborate pressure

* Read before the American Association for the Advancement of Science, August 23, 1898.

gauge adapted to measure small pressures with very great precision, and a barometric gauge for measuring larger pressures.

In using this apparatus the gas to be tested was introduced at atmospheric pressure; the ice tank was raised, and the falling temperature of the thermometer, which could lose heat only by radiation, conduction and convection through the surrounding gas, was observed through a telescope. The time required for the temperature to fall through a given range, usually from 15° to 10° Centigrade, was carefully noted. Then the ice tank was lowered, permitting the thermometer to regain the temperature of the laboratory; some of the gas was pumped out, and the cooling of the thermometer again observed at this reduced pressure. This process was repeated many times, until the pressure was reduced to the lowest point attainable.

The results obtained with each gas were plotted in a curve showing its heat conductivity at all pressures from atmospheric down; the ordinates representing the reciprocals of the time of cooling in seconds, while the abscissas represented the pressure.

The present chart shows curves representing the heat conductivity of several gases, from fifty millionths of atmospheric pressure downward. The data for all of these, except the helium curve, are taken from last year's paper; but the scale is different.

I am indebted to Professor Ramsay for the helium used in obtaining the curve here shown.

The ordinates of each curve measured from A B as a base line represent the total rate of heat transmission by the ether and the gas at the pressures indicated by the abscissas, while ordinates measured from the line C D represent the heat transmitted by the gas alone.

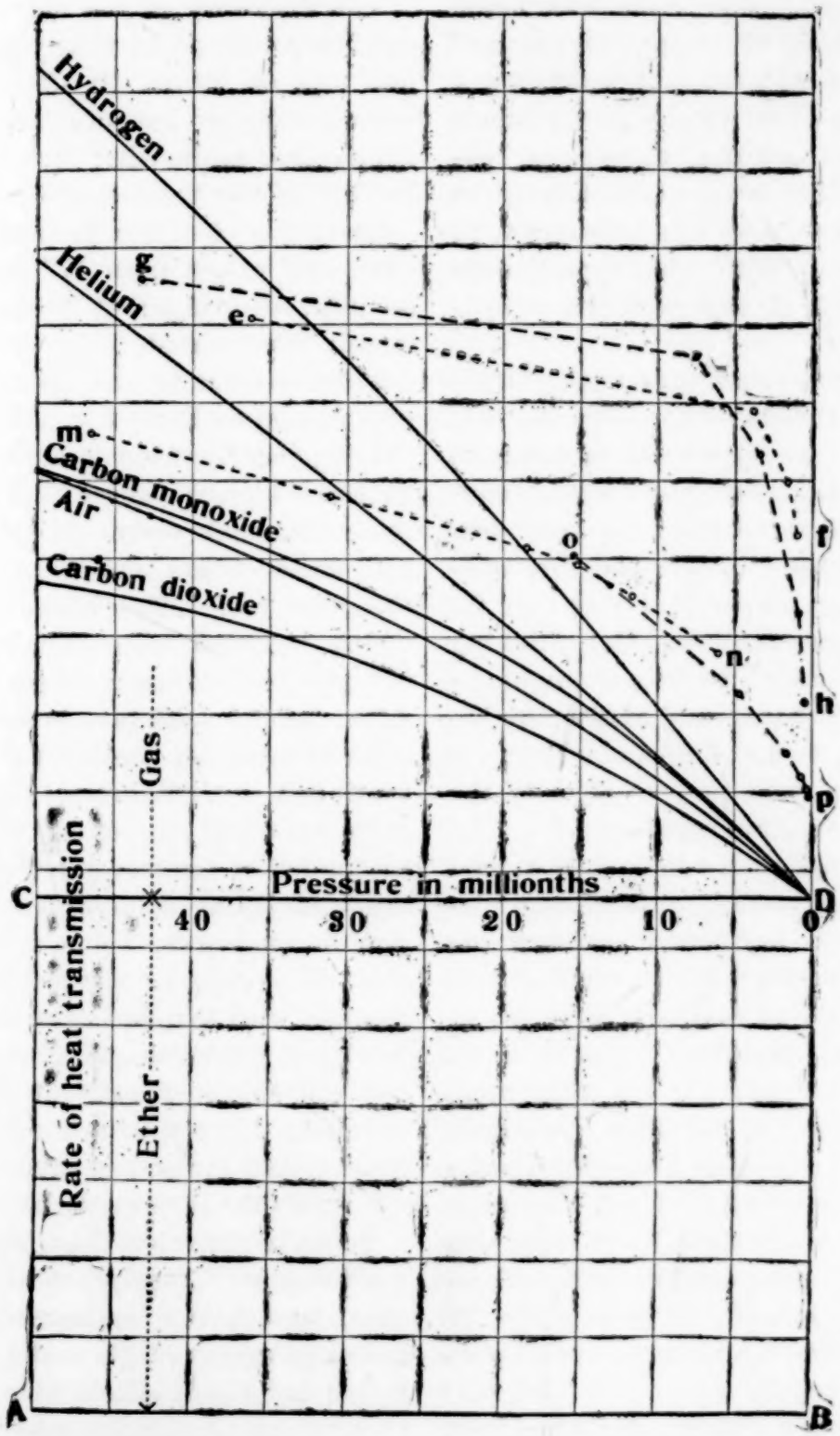
It will be observed that the curves of all the gases named vanish together at the point of zero pressure D. Repeated experiments have shown this condition to be always strictly true within the narrow limits of errors of observation, provided that, before the introduction of the gas to be tested, the whole apparatus has been kept highly exhausted for several days; or, better still, has been heated several hours by means of air and water baths, while kept exhausted. Without one of these precautions I was never able to get any gas curve quite down to the point D, for reasons which will appear. The point D represents a period of three hundred seconds required for the temperature of the thermometer to fall from 15° to 10°, with the pressure of the surrounding gas reduced to one twenty-millionth or less.

A very brief account of the circumstances which led to the discovery of the new gas may not be out of place. I had long been engaged in high vacua experiments, and had observed that glass apparatus, when highly exhausted and heated, evolved gas for an indefinite length of time, rapidly at first, then slower, but never stopping until the temperature was reduced. On cooling, rapid reabsorption always took place, but was never complete; indicating that two or more gases had been evolved by heating, one of which was not absorbed by cooling. In other words, the absorption was selective. The truth of this conclusion was abundantly demonstrated subsequently. However, the percentage of reabsorbed gas was so large that I used a small quantity of pulverized glass in several experiments to absorb a part of the residual gas after the highest attainable exhaustion was reached. The pulverized glass was always lead glass like that of the apparatus, and was heated nearly red-hot for several hours before and during the final exhaustion.

During these experiments a curious phenomenon was noted—the pulverized glass lost its snowy whiteness. This I thought

must be due to reduction of some of its lead, probably by hydrogen evolved on glass; and its presence in the glass, if proved, would be a long step toward proving the normal presence of hydrogen in the atmosphere.

Chart Showing Relative Heat Conductivity of Gases.



Following the line of experiment thus heating. If so, I argued that the hydrogen must have been absorbed from the atmosphere since the manufacture of the

suggested, I prepared a quantity of pulverized soda glass free from lead and placed about 120 grams of it in a large combustion tube connected with the apparatus already described. The glass was made from an old stock of tubing, and was of such a degree of fineness that it all passed through a sieve of 90 meshes to the linear inch, but would not pass through a 140-mesh sieve. The combustion tube was adapted to be heated by a gas furnace with automatically regulated gas supply, so as to be maintained at any desired temperature.

While prepared to make analysis, in the usual way, of the gas evolved by the pulverized glass in case it appeared in sufficient quantity, I relied chiefly on its heat conductivity for the detection of any large proportion of hydrogen in the last few millionths, not being prepared at that time for spectroscopic examination; and thinking that, perhaps, some hydrogen might be evolved in the last stages of exhaustion before heating, I tested the conductivity of the residual air from time to time as the preliminary exhaustion progressed.

When the exhaustion approached a good vacuum an astounding phenomenon developed. At 36 millionths pressure the residual gas conducted heat twice as well as air, and nearly as well as hydrogen; at 3.8 millionths it conducted seven times as rapidly as hydrogen; at 1.6 millionths, fourteen times, and at .96 of one millionth, twenty times as rapidly. These results are plotted in the curve *e f*. I did not carry the exhaustion lower than .96 M. At this pressure the time of cooling of the thermometer from 15° to 10° was only 177 seconds, while pure hydrogen would have required 288 seconds.

Evidently a new gas of enormous heat conducting capacity was present, mixed with the last small portion of air. It must have come from the pulverized glass, and probably formed only a small fraction of the mixture. The last cc. of gas pumped out was collected, and upon subsequent analysis of it nothing but air was found.

The discovery of the new gas, as above outlined, was made nearly a year and a half ago, on March 10, 1897. On the following day the pressure had increased to nearly five millionths; while the time of cooling of the thermometer, instead of diminishing as usual with increase of pressure, had raised from 177 seconds to 245 seconds, showing that the new gas had largely disappeared. This was subsequently found to be due to absorption by the phosphorus pentoxide used in desiccation.

Long continued moderate heating of the pulverized glass caused the evolution of some air, much carbon dioxide and hydrogen, some carbon monoxide, and more of the new gas. The selective absorption which occurred on cooling was confined almost wholly to the hydrogen and new gas. After further moderate heating and thorough exhaustion, I raised the temperature, continued the exhaustion, and got the results embodied in the curve *g h*, showing that much of the new gas was present; the conductivity at .38 millionth, the last station in the curve, being *twenty-seven times* that of hydrogen. Several days of high heating, with frequent exhaustion, failed to wholly deprive the pulverized glass of its new gas, though the output was greatly diminished. For this and other reasons, I believe that the new gas resides *in* and not simply on the surface of glass.

To make sure that the apparatus was not deceiving me, I sealed off the combustion tube, heated the vacuous parts several hours by means of air and water baths as before indicated, admitted air dried over phosphorus pentoxide, exhausted step by step, and got the data for the 'small-bulb' air curve shown here and in last year's paper. Evidently I had not been deceived

about the presence of a new gas in the pulverized glass. I subsequently exposed this lot of glass several days to the atmosphere, spread out in a thin layer. When tested again after this exposure it yielded the new gas, both before and after heating, as freely as at first. This rejuvenation of pulverized glass by exposure to the air was fully confirmed with another lot made from common window glass, and in connection with the results obtained by the diffusion of air, hereafter described, leaves no room for doubt that the new gas is a constituent of the atmosphere.

Pulverized glass appears to begin evolution of the new gas as soon as the atmospheric pressure is reduced. In one case, while making a slow preliminary exhaustion, I tested the air which remained when the pressure was still 132 mm., and, to my great surprise, found it contained not only a trace, but a considerable quantity of new gas. The amount increased rapidly as the pressure was further reduced. This leads to the belief that finely pulverized glass gives up the greater part of its new gas on simple reduction of pressure to a low point, and without heating; somewhat as palladium gives up occluded hydrogen.

Several substances other than glass were examined, and nearly all found to contain the new gas. A specimen of old charcoal made from pine-wood sawdust by long exposure to a bright red heat yielded as was expected, comparatively large quantities of several gases when heated in vacuum. At some stages of the evolution these were rich in the new gas.

It would seem easy in such cases to remove the diluent gases by oxidation and absorption; but it is not. After making the necessary additions to my apparatus, I made many attempts of this kind. The reagents used were in large excess on account of the very small quantities of gas treated; so that some of the observed results may have been due to impurities. Cupric oxide and lead chromate evolved gases of their own almost indefinitely on high heating in vacuum, and then freely absorbed carbon dioxide and moisture at a lower temperature. Soda-lime dried in vacuum in presence of phosphorus pentoxide was almost indifferent to carbon dioxide. All the reagents named, especially phosphorus pentoxide, absorbed the new gas; and all but the latter give it up again on heating.

A specimen of very fine white silicious sand, when heated in vacuum, gave a large quantity of gas consisting principally of hydrogen and hydrocarbons, with a considerable amount of the new gas. Some of this mixture was exposed successively to the action of red-hot cupric oxide, soda-lime and phosphorus pentoxide. By this treatment the gases were reduced to less than three per cent. of their former volume. The residue was not very rich in the new gas, because of the absorption of the latter by the soda-lime and phosphorus pentoxide, as I afterwards learned; but I have shown the curve *o p* of its heat conductivity, because the pressure was carried to a lower point than in any other case. At the last station in the curve, representing a pressure of .12 of a millionth, the conductivity was equal to that of 5.1 millionths, or forty-two times as much hydrogen. From this it seems reasonably certain that the curve *e f*, if carried to as low a pressure, would have shown a conductivity at least a hundred times greater than hydrogen. And yet the new gas in that experiment must have been very far from pure on account of the continuous evolution of ordinary gases, as shown by the rise of pressure and loss of conductivity during the next few hours.

It will be observed that when the new gas was present the form of the conductivity curves was very different from those of the known gases, the effect of the new

gas becoming more prominent as the pressure was reduced. I do not doubt that this was due to the interference of the heavier and slower moving molecules of the ordinary gases always mixed with the new gas. In last year's paper I described the same effect found in a mixture of carbon dioxide and hydrogen. When the new gas is obtained in a state of purity I expect to find its curve of heat conductivity similar to those of hydrogen and helium, but with immensely increased ordinates.

Believing that the new gas is very much lighter than air or hydrogen, and may therefore be separated from the atmosphere by successive diffusions, I have spent several months in experiments with this end in view. Quite recently my efforts have been crowned with most promising success. The difficulty has been to find a suitable porous septum; one free from holes, and sufficiently fine-grained to prevent more than a very slow passage of air, while a considerable surface is exposed to the atmosphere on one side, and to a fairly good vacuum on the other. Many substances were tried. India-rubber gave encouraging results, but was capricious and very slow. The best results have been obtained with porous porcelain having its superficial pores nearly closed by suitable treatment. A tube of this kind, closed at one end, and exposing rather more than five square inches of surface to the air, was connected with the apparatus, and the whole kept exhausted to a pressure of 1.3 mm. About 19 cc. of gas was diffused per hour. After 36 hours the diffusion tube was shut off, the exhaustion continued, and data for the curve *m n* obtained. It was found impracticable to carry the exhaustion below six millionths, because of the presence of moisture, which interfered with the action of the pump, no desiccating agent being used. As both phosphorus pentoxide and soda-lime absorb the new gas they cannot be used for desiccation. If the exhaustion had been carried as far as in the curve *o p* it is probable that a higher conductivity than in that curve would have been shown; *i. e.*, a conductivity more than 42 times that of hydrogen, or something like a hundred times that of air. Here we have the heat conductivity of air at very low pressure, increased something like a hundred-fold by one diffusion. I have not yet tried a secondary diffusion, but feel confident that successive diffusions of air will afford a practicable means of obtaining the new gas in a state of approximate purity.

Now let us discover, if possible, the meaning of the extraordinary heat conductivity of the new gas. I have tabulated the molecular weight, density, specific heat, mean molecular velocity and heat conductivity of hydrogen, helium, carbon monoxide, air and carbon dioxide, which are the known gases represented in the curve chart. For easy comparison, I have taken not only the density, but the specific heat, mean molecular velocity and heat conductivity of hydrogen as unity. The similarity of values in the fifth and sixth columns, for molecular velocity and heat conductivity, is striking. On the chart the curves for carbon monoxide, air and carbon dioxide are evidently too high to correspond well with the relative values of molecular velocity in the fifth column; but these curves represent only the last 50 millionths of the complete curves. By following these back to 500 millionths, which is still a rather small pressure, and taking their values at intervals of 10 millionths from no pressure upward, we obtain as a mean of all these values for each gas the quantities shown in the sixth column. These agree fairly well with the molecular velocities.

I offer the suggestion that the relatively high conductivity of the last three gases at the low pressure shown in the chart is due to the dissociation of some of their mole-

cules by unobstructed impact on the walls of the containing vessel; recombination being more and more retarded as the pressure is lessened, because the greater separation of the molecules reduces the frequency of collisions. Helium, perhaps because it is monatomic and therefore incapable of dissociation, has a nearly straight curve like hydrogen; and its ratio, given in the sixth column, varies but little throughout the whole range observed, which was more than a thousand millionths. I have taken the density of helium as 2, but Professor Ramsay finds it a little less than this when purified as far as possible by repeated diffusions. This makes its relative molecular velocity a little more than .71, and brings it still closer to the observed value of its heat conductivity.

From the foregoing, we may reasonably conclude that the heat conductivity of gases at low pressures, and their mean molecular velocities, are closely related. Hence, if we can learn the heat conductivity of an otherwise unknown gas we can form some idea of its mean molecular velocity; and from this, of its specific heat, density and molecular weight.

As before indicated, the heat conductivity of the new gas at very low pressure, even when mixed with a large proportion of other gases, is something like a hundred times that of hydrogen. I shall not be surprised to find the conductivity of the pure gas a thousand or more times greater than that of hydrogen; but let us be conservative, and for the present purpose call it a hundred times and see what follows. I have given it this value at the head of the sixth column.

Comparison of Gaseous Properties.

1	2	3	4	5	6
Gas	Molecular weight	Density D	Relative specific heat	Relative molecular velocity $\frac{1}{\sqrt{D}}$	Relative heat conductivity
Etherion	? 0.0002	? 0.0001	6000.?	100.?	100.
Hydrogen	2.	1.	1.	1.	1.
Helium	4.	2.	?.300	0.71	0.73
Carbon monoxide	27.8	13.9	0.072	0.27	0.33
Air	28.8	14.4	0.069	0.26	0.32
Carbon dioxide	43.8	21.9	0.064	0.21	0.21

If my inference that the heat conductivity and molecular velocity of gases are directly related is correct, then the molecular velocity of the new gas will be 100 times that of hydrogen, as shown at the head of the fifth column. As is well known, the mean molecular velocity of a gas varies directly with the square root of its absolute temperature, and is independent of pressure. The mean molecular velocity of hydrogen at the temperature of melting ice has been found by calculation to be 5,571 feet per second. Hence the mean molecular velocity of the new gas at the same temperature will be 557,100 feet, or more than 105 miles per second. At anything like this molecular velocity it would be quite impossible for a gas to remain in the atmosphere, *unless the space above also contained it.* A velocity of only about seven miles per second, if un-

checked except by gravitation, would be sufficient to project a body from the earth permanently into space. Even at a temperature very close to absolute zero the new gas would have sufficient molecular velocity to escape from the atmosphere.

Again, inasmuch as the molecular velocities of gases vary inversely as the square roots of their densities, it follows from our assumption of its molecular velocity that the density of the new gas is only the ten-thousandth part that of hydrogen, as shown at the head of column 3. This is the hundred and forty-four thousandth part the density of air. It is generally believed that the gases of the atmosphere distribute themselves in the long run, each as though the others were absent. Hence the new gas must extend a hundred and forty-four thousand times as high as the heavy constituents of the air to bring about the same proportionate reduction of pressure, even if gravitation remained constant at all distances from the earth; but the restraining influence of gravitation on the expansion of the atmosphere diminishes as the square of the distance from the earth's center increases.

It is evident, therefore, without a mathematical demonstration, that the new gas, being present in the atmosphere, must extend indefinitely into space without great loss of pressure. This is only another way of stating the result of its assumed molecular velocity. Now, there is no doubt that the new gas exists in the atmosphere, though probably in very small proportion, perhaps much less than a millionth. Hence it seems really probable that it not only extends far beyond the atmosphere, but fills all celestial space at a very small pressure. In recognition of this probability, I have provisionally named it ætherion, or etherion, meaning 'high in the heavens.' Its symbol will naturally be Et.

I am aware that strong objections may well be raised to the hypothesis of an inter-planetary and inter-stellar atmosphere; but I can see no escape from the conclusion I have drawn, if I am not mistaken in my premises.

The estimated relative specific heat of etherion appears at the head of the fourth column, based again on the assumed relative molecular velocity. In estimating the specific heat, I have not made it inversely proportional to the density, as would be required by Dulong and Petit's law, giving a value ten thousand times that of hydrogen; but have used the formula suggested by Professor Risteen in his work on 'Molecules and the Molecular Theory,' which requires that the product of the specific heat and molecular weight of gases shall vary with the number of degrees of freedom of their molecules. I have assumed as probably true that etherion is monatomic, with atoms possessing only three degrees of freedom.

Of course, the values I have estimated for the molecular weight, density, specific heat and molecular velocity of etherion are intended only to indicate the *order* of magnitudes we may expect to find on further investigation; and it must not be forgotten that they are based on two assumptions: first, that the heat conductivity of etherion is 100 times that of hydrogen; and second, that the ratio of heat conductivity and mean molecular velocity is the same for all gases. As before indicated, I expect to find the heat conductivity of etherion much higher than the value here assigned to it. If so, the real value of its other attributes will be still more startling than those here given. The second assumption, while by no means proved, seems at least a good 'first approximation' to the relation between heat conductivity and molecular velocity in gases.

There is some evidence that etherion is a mixture of at least two different gases. In the course of my experiments I have met

with a great many specimens, obtained in various ways from various sources, but always mixed with a very large excess of other gases. Some specimens were almost wholly absorbed by the phosphorus pentoxide at first used for desiccation. Others were but partially absorbed; the absorption being very rapid at first, but in an hour or two dwindling to nothing, and leaving a residue of gases permanently showing, by their heat conductivity, the presence of a very considerable amount of etherion. Soda-lime absorbed etherion, but much less freely than phosphorus pentoxide, and gave it up again on heating. The gas thus recovered was but little, if at all, affected by phosphorus pentoxide.

In one experiment the gases evolved from ten ounces of pulverized window glass, both before and after heating, were passed through coarsely pulverized soda-lime and then over fresh phosphorus pentoxide. Not a trace of etherion remained. The same result was obtained when another lot of the silicious sand, already referred to, was used as the source of etherion.

I will venture the conjecture that etherion will be found to consist of a mixture of three or more gases, forming one or more periodic groups of new elements, all very much lighter than hydrogen. If this proves true I propose to retain the present name for the lightest one.

The transmission of radiant energy through space has always been to me a fascinating phenomenon, and I have indulged in much speculation concerning the ether—that mysterious something by means of which it is effected. The remarkable properties assigned to the ether from time to time, in order to account for observed phenomena, have excited my keen interest; but I have long entertained the hope that some simpler explanation of the mechanism involved will be found. To me, a less strain of the imagination is required in the assumption that, instead of a continuous medium, gaseous molecules of some kind, endowed perhaps with a mode or modes of motion at present unknown to us, are the agent of transmission; a gas so subtle, and existing everywhere in such small quantity, that it has escaped detection.

Perhaps the molecular hypothesis of the ether has proved so attractive to me because it supports the hope that we may sometime compass the perfect vacuum—a portion of space devoid of *everything*. Such a vacuum would be opaque to light, and gravitative attraction could not, I believe, act through it. It might afford a new point of view from which to study the profound mystery of gravitation; an *outside* point.

The late De Volson Wood (*Phil. Mag.*, Nov., 1885) considered the question of a gaseous ether mathematically, and deduced certain necessary properties of the hypothetical gas; chief among which were exceedingly small density and exceedingly high specific heat. Possibly we are about to find a gas which will fulfil the required conditions. It may be etherion, or its lightest constituent if it turns out to be a mixture. I venture to express the hope that etherion will at least account for some phenomena at present attributed to the ether.

On account of the presumably extreme smallness of its molecules as compared with those of glass, etherion probably passes through the latter when any considerable difference of pressure exists on opposite sides; though the passage may be very slow. It seems to be condensed or compressed in glass as before indicated, and may evaporate on the side of lower pressure, and be absorbed on the side of higher pressure, after the manner of hydrogen in passing through palladium. In my own experiments the heat transmission ascribed to the ether may be due to the presence of the new

gas inside the bulb. A small fraction of a millionth would be sufficient, and this might escape detection by the pressure gauge, on account of the necessary compression in the gauge head causing absorption by the glass. Again, etherion must always be present to some extent in all 'vacuum tubes' (as well as in my own conduction bulb), on account of its long continued evolution from glass, and may be the medium of propagation of the Röntgen rays in the vacuum glass and air.

Charles F. Brush.

Cleveland, O.

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*THE NEW YORK STATE COLLEGE OF FORESTRY.**

Ever since the American Forestry Association was formed at Cincinnati, in 1882, the need of providing for forestry education has been a favorite topic at the meetings. There were those who wished to make the subject a part of the studies in the public schools, and others who desired the establishment of special schools, either separate or in connection with other educational institutions.

Fortunately for our public schools and over-burdened school teachers, who are struggling not always quite successfully to do justice to their legitimate functions, the schemes of our enthusiastic forestry reformers in the first direction have not matured beyond the introduction of an Arbor Day celebration, perhaps an occasional reading or talk, quite sufficient to call the attention of the young mind to the existence and significance of the subject.

Those who had higher aims and expected that the existence of technically educated foresters would pave the way to the application of their art contemplated, in their philanthropic desires, the sacrifice of the individual to the cause; for unless the students issuing from such forestry schools had other means of subsistence, their bread, if they could earn it, would hardly have been buttered through their knowledge of forestry.

It may be set down as an axiom that the employment of any specialist in a technical art comes, as a rule, when the economic conditions are ripe for such employment.

In the United States the exploitation of all resources has, as in every newly-settled country, been carried on without the technically educated specialist; until 1870 or thereabout mining engineers were a rarity, and the exploitation of the soil by agriculture has only just begun to be considered an art; agricultural rapine is still largely the practice, just as the natural resources of the forest are and will be still for some time the object of the lumberman's rapine.

When does the time for a change come? When does it become necessary to employ skill and art in the use of our resources? These are difficult questions to answer. In a general way, from the standpoint of the individual the answer can only be one, namely, 'when it pays;' a consideration of supply and market conditions determines for him when his financial interests are best subserved by the use of greater skill and knowledge. He may not always recognize the right moment, but it would be a profit calculation which would have to be employed to persuade him of its arrival.

From the standpoint of the community, the State, the financial consideration may be quite secondary; the interest in the preservation of certain favorable conditions may justify an expenditure, a sacrifice of the present for the sake of the future.

It was the recognition that such an interest existed which induced the State of New York to take a first step with regard to her forest resources thirteen years ago by ceasing to dispose of the forest lands which the State had unwillingly acquired through

* Read before the American Forestry Association at Boston, August, 1898.

non-payment of taxes by the owners. A further recognition of the importance of this interest followed two years ago by establishing the policy of land purchases for the increase of this area, under which policy one million dollars was expended last year and half a million is at the disposal of the Forest Preserve Board this year, while it is expected by further purchases to increase the State forest property to three million acres, more or less. This year a further, logical step in the pursuit of this State policy was made by establishing a forestry school for the professional education of the managers of this State property and an experimental forest area, in which the method of managing the property might be developed and elaborated.

This school, the New York State College of Forestry, has the distinction of being the first institution of its kind in this country where a professional study of the whole subject of forestry in all its phases may be pursued with opportunities almost equal to the best in European forestry schools, except for the absence of object lessons, which it will take some time to create.

Thus, while the art of forestry is as yet hardly practiced, a place for the study of the science, which must underlie the application of the art, is established; and this entails the moral obligation upon the State to proceed on its path to a technical management of its forest property.

We may recall that the original forestry law of New York, which was mainly drafted by the writer and passed in 1885, contemplated a technical forest management of the State property and hence conferred upon the then established Forest Commission the right to cut and sell wood.

But no professional foresters were employed and no technical forest management was attempted; the right to cut and sell was exercised simply in selling stumpage of spruce to lumbermen.

The public, laboring under the mistaken notion that forest preservation required cessation of all cutting of trees, and not trusting to the discretion of its officers—rightly or wrongly—attempted to remedy the absence of technical advice by inserting into the constitution of the State a clause which prevents all cutting of wood on State lands —a foolish provision from the forester's point of view, but perhaps, from the standpoint of expediency at the time, not entirely reprehensible.

It became apparent that, before a rational forest management could be secured, it was still necessary to educate the people first to a true conception of what that involves; that an object lesson was needed in order to show that forest preservation did not mean 'Woodman, spare that tree,' but 'Woodman, cut those trees judiciously;' in other words, that forest utilization and forest preservation by means of forest reproduction were not incompatible.

Imbued with this idea, the Superintendent of the reorganized or consolidated Fisheries, Game and Forest Commission, in his report for 1896, suggested the establishment of such a demonstration of technical forest management.

Governor Black, taking interest in the proposition, conceived the idea that such an experiment, requiring a long time of continuous, unchanged policy, had best be removed from the ever-changing influences of politics and should be entrusted to a strong and stable educational institution.

This thought suggested the desirability of going a step farther, namely, to provide at the same time for the education of professional foresters, the future managers of the State's forest property, when, with the accomplished demonstration and the existence of competent technical advice, the constitutional bar to rational forestry might be removed.

Cornell University was selected to under-

take the experiment; a bill was drafted and introduced into the Legislature early in February, was passed and received the Governor's signature in April, and on the 16th of that month, by action of the Board of Trustees, the University accepted the responsibility and established the college by election of the writer as its director.

Although a State institution, and as such dependent upon appropriations provided by the Legislature, the College, while having its own separate faculty organization, is organically connected with the University and has the benefit of the entire apparatus of the same with the 180 or more professors and instructors, at least 30 of whom will be called upon to furnish instruction to students of the College in fundamental and supplementary sciences.

In thus connecting the forestry school with a fully equipped university the most advanced German ideas in forestry education are realized. While in that country, in which forestry is most advanced, only three of the nine higher schools of forestry are located at universities, it has become more and more apparent to the educators, even to the directors of the separate institutions, that the advantages derived from the broader education and fuller equipments of universities far outweigh the advantages of the separate academy, which were mainly seen in their location near the woods and demonstration areas. It is now recognized that with modern methods of communication the woods can be more readily reached from a railroad center; that at any rate only a limited amount of practical instruction is possible at the school, wherever situated, the practice coming preferably after a thorough theoretical instruction; and, finally, that the local isolation of the academy is a detriment both to professors and students by its mental isolation. At the university the courses in fundamental and supplementary sciences, which include mathematics, physics, chemistry, geology, botany, zoology, political economy, engineering, law, can naturally be more thoroughly provided.

For the present there are three teachers of forestry provided at the new college, namely, the director and two instructors, with the possibility of using the manager of the demonstration or college forest to assist, although the distance of the latter would make such participation of the manager in educational lines possible only during summer courses and on excursions to the school forest.

This teaching force is equal to the lowest requirements and can be satisfactory only in the beginning, while the college is in its infancy. The best German institutions have four and five full professors, and only the less favored are satisfied with two full professors of forestry, who are then not burdened with administrative functions.

The University of Munich has six professors of forestry, of whom two, however, are teachers of dendrology and soil physics, which are not exactly forestry branches, but form fundamentals to be taught in the departments of botany and geology.

A satisfactory organization which would do justice both to the teaching and the investigation work, such as is here even more needed than abroad, would require three full professors with at least two instructors or assistants corresponding to the three groups into which forestry subjects can be divided according to their bases, namely: those which are mainly based upon natural sciences and are concerned with forest crop production—silviculture, forest protection, timber physics; those which are mainly based upon mathematics and engineering knowledge and are concerned with the practical management of a forest property —forest exploitation, forest mensuration and forest regulation; those which are mainly of a philosophical character, requir-

ing a full appreciation of all the bearings of the subject, under which head forest administration, forest valuation and statics, history, statistics and forestry politics may be grouped.

The assistants would find ample work in aiding the professors in the lecture room, on excursions or practical demonstrations and in carrying on special investigations.

In spite of the present deficiency in the faculty, which is, moreover, on account of the deficient appropriations—$10,000 for the first year—limited to the director and only one assistant professor, who acts also as forest manager, the courses of studies announced have been nevertheless made full, comprising twelve courses, the expectation being that no students for the senior year will be ready before the deficiency in the faculty may be supplied under increased appropriations.

The course of studies leading to the degree of Bachelor in the Science of Forestry has been made to cover four years, corresponding in this particular also not to the general practice, but to the most advanced ideas of German educators in forestry. In this course the first two years are entirely given up to studies of the fundamental sciences, while forestry subjects and supplemental studies are left for the last two years. This arrangement has the advantage that forestry students may lay their foundations at any other institution, and, also, should any entering upon the course for some reason desire to abandon their purpose they will not have wasted any time on the specialty, but find themselves prepared for any other study involving natural sciences as a basis.

The required fundamental and supplemental courses comprise altogether about 1,270 hours, to which 450 hours' supplemental work are added as elective but desirable, while the forestry branches represent about 600 hours, of which 130 are optional, making an average of about 17 hours per week of required and elective work.

In the fundamental branches, botany, chemistry and geology, with allied sciences, require the foremost attention, while a considerable amount of time is given to mathematics, entomology, political economy and engineering, especially map-making and road-building. It is also proposed to add a course on pisciculture and venery, since the future forest managers, at least on the State property, will undoubtedly have charge of the taking care of fish and game, which generally or often form parts of a forest property.

While these full courses are designed to equip, as completely as may be, managers of large properties on which wood-cropping is to be carried on as a business, the College will also endeavor to satisfy other classes of students who desire only a more or less cursory knowledge of the subject or some of its branches, such as students of political economy, or owners of timber lands, who wish to practice at least silviculture. Finally, the requirement of the law, which prescribes that the College shall impart the results of the management of the demonstration forest, will be construed to mean that the function of the College is to pull up the stumps of ignorance regarding forestry wherever they present themselves; the University Extension spirit will prevail.

Later, it may also establish summer schools designed to educate foremen and under-foresters in the principles of forestry, an educational move which is as much needed as that for the training of forest managers, for which the College is originally designed to provide.

The one drawback under which the College will labor at first and for some time to come is the absence of object lessons in the field, the demonstration of principles applied in practice. To be sure, a demonstra-

tion area of 30,000 acres has been set aside in the Adirondacks, which will in time supply the deficiency—sooner in some directions, later in others, since results in forest management are as slow to accomplish as the slowness of the crop would lead us to expect.

Since, however, the conditions in the Adirondacks are special, not only on account of the topography and climate, but because of the few species of timber trees involved, this one demonstration area cannot suffice, and in order to get variety of conditions other areas will have to be secured.

This does not necessarily imply purchase of such areas by the State; it will be possible by and by to secure the cooperation of private timber-land owners, who may permit the College to prepare working plans for their lands and may be willing to apply forestry principles in their management, first, in that generous spirit by which all our educational movements are supported, and finally because of the financial benefits they may derive from it.

There are now some such attempts at forest management to be found in various parts of the country which may be visited by the students during excursions in vacation time. Finally, a visit to the European forests under management will be found profitable to students at the end of their studies, and with full theoretical knowledge to guide them even a brief visit will be full of interest and educational value.

The demonstration in the Adirondacks, as far as forest regulation and administration is concerned, may be made to form a pattern for almost any other region; as far as *silvicultural* methods are concerned, its teachings will be applicable not only to the entire Adirondacks, but to a large part of the New England forest areas, in which spruce is or has been the principal timber tree.

It may be interesting and useful for a fuller conception of what is involved in forest management to point out briefly what the policy and *modus operandi* to be pursued in the college forest is to be.

The leading thought in the management of a forest property is *permanency*, for it contemplates the devotion of the soil to the continued production of a crop, which it takes a century, more or less, to mature. Hence all plans and all operations must take into consideration a long future and all preparations must be made, as for a stable, permanent conduct of a business, unlike those of the lumberman, who exploits the forest only as a speculation, who is not in the business of forest or wood production, but is a mere harvester, the difference being similar to that between the breeder of cattle and the butcher.

The first business of the forester, then, is to become thoroughly acquainted with all the details of his property. He must study its topography, with special reference to the possibilities of making every part accessible to market at any time for its various products. He must know its soil conditions to judge of the variable productiveness of each acre; its forest conditions, to give an insight as to the kind of operations required in each part, in order that the forest may be brought into most productive condition; its contents of merchantable material and rate of growth to determine the amount of annual harvest, which a conservative management will permit. This forest survey is made in connection with or preferably on the basis of a topographical survey.

Next comes the task of preparing the property for an orderly and systematic business conduct by dividing it into subdivisions or compartments of smaller or larger area, business units, which may be designated by letters or numbers, just as the blocks and houses in a city or the rooms in a hotel are numbered for con-

venient administration. The subdivisions, based on topography, difference of soil, forest conditions and other business and silvicultural considerations, may or may not at first be permanently designated in the forest, but finally they will be so fixed, not only on the map, but on the ground, and, possibly, by opening lanes between the compartments, which are preferably so located that they can be used as roads. In the end, the ideal organized, managed forest will look not unlike a city with streets, making every part of the property readily accessible. In practice this ideal may never be quite attained and temporary means of transportation, like rope-ways, movable railways, log-slides, etc., may be substituted for the roadways, where more practicable, just as elevators supplant the stairs in the apartment and business house.

While this more or less geometrical and arithmetical basis for management is laid and partly, as a result of these data, collected, the general policy of management is determined upon and finally its progress is regulated by working plans, for a more distant future in general and for the nearest future in detail.

The manner in which this forest regulation proceeds may be as follows:

We have to deal in the Adirondacks with a mixed forest of hardwoods, birch, maple and beech, in which spruce forms a prominent admixture, sometimes at high elevations, the latter occupying the ground almost exclusively; and of other useful species, not merely weeds, white pine, fir, cedar and aspen occur more or less scattered or in groups.

We come to the conclusion that, all points considered, the spruce in these mountains is the most valuable timber, with the other conifers desirable concomitants, the hardwoods, although now in preponderance, being less readily marketable; and we also consider that this relative value of the species will continue for the future, since the use of the spruce for paper pulp, with few desirable substitutes known, promises continued market for even the inferior material.

Hence we formulate our silvicultural policy: The management is to be based for spruce. It is to be the endeavor to change from the present condition of hardwoods with an admixture of spruce to spruce with an admixture of hardwoods, the admixture being considered desirable for various reasons, among which specially counts the danger to which the shallow-rooted spruce is exposed from winds, which is alleviated by association with other species.

To carry out this policy it is evident the hardwoods must be numerically reduced, the conditions for the reproduction of spruce made favorable and the young growth of spruce favored by subduing its competitors —operations which require the highest skill of the silviculturist.

At the same time the administrator's care is to secure a market for the hardwoods and the means of transporting the same cheaply enough to at least pay for their removal. In this respect it is not enough to sit still and wait for the consumer to come, but active canvass and perhaps reform in the methods of the market and the utilization of the product may be necessary. There are as wasteful methods still to be found in the market and the manufacture of wood materials as in the exploitation in the forest, and reform in the latter direction depends largely on reform in the former. A study of the market, therefore, of its requirements and possibilities of change is most essential for the successful forest manager.

A further formulation of silvicultural policy is as to the kind or system of management under which the reproduction is to be secured. There are two general classes possible. Cutting away the old growth and

planting a new crop just as wanted appears the simplest system. Yet, aside from other flaws which adhere to this method, it would under our conditions of labor be too expensive to employ, except on such areas as are now denuded or devoid of desirable species, or else for demonstration of methods and results. In such cases other species adapted to the locality and promising both silvicultural and financial success, among which especially is the white pine, would be favored.

The other class of management for reproduction, which depends upon natural seeding from the trees on or near the area to be reproduced, offers several methods, among which the method of selection in which mature trees here and there selected through the forest, or certain parts of it, are taken resembles most the lumbermen's present method, except that he is influenced only by the marketableness of his trees, while the forester keeps foremost the benefit to the young growth that is left. This method is especially adapted to those portions which are situated on the high elevations, crags and heads and wherever it is dangerous to expose the soil. Modifications of this system, for instance one in which groups of trees are removed and the reproduction, therefore, is secured by clumps rather than by single individuals, may be acceptable in other parts of the property, and finally for the sake of demonstration all other systems of management, such as the strip system, the nurse-tree system, etc., may be practiced on smaller or larger areas.

One of the most difficult and important questions to be determined, especially with regard to financial results, is the rotation, *i. e.*, the age to which the crop is to be allowed to grow before utilizing it. Unlike other crops, the harvest time of which is determined by natural limits, their ripeness, the harvest of the wood crop is not so circumscribed. There is a choice as to when to harvest it, into the making of which a number of considerations enter. First, of course, useful size is the main consideration; the production of hoop poles, hop poles, vineyard stakes may be satisfied by a ten to twenty years' growth; railroad ties may be secured in thirty to forty years, and so on. Where reproduction from seed is expected, the age at which frequent and prolific seed production takes place, maturity in the sense accepted for animals will set the lowest limit; finally, however, since the business of forest production is mainly carried on for financial results, the financial rotation must be determined, *i. e.*, that time at which it pays best to harvest the crop. Quantity of production as well as change in quality, both of which are variable with age of the crop and market conditions, influence its choice. A series of measurements of the rate of growth of the wood crop and calculations based on them and on cost of production and administration and consideration of market requirements, present and conjectured future ones, lead to the adoption of this regulator of the time element in reproduction.

These calculations may lead us to adopt a rotation of eighty years for parts of our school forest of spruce with hardwoods and 100 years or more for other parts; that means we would distribute our fellings in such a manner that by annually or periodically equal or nearly equal amounts we remove all the wood that has been produced during the period of 80 or 100 years respectively, taking care that as much wood is left to form what is called the normal stock of wood, the working capital of wood necessary to secure by annual accretions the most desirable and profitable production of which the property is capable.

These calculations also lead finally to the conclusion as to the amount of wood that may be annually or periodically cut without

reducing the normal stock or wood capital and representing, as it were, the interest. We may, for instance, come to the conclusion that on our 30,000-acre tract an annual felling budget of two to three million feet, B. M., of logs and eight to ten thousand cords of wood may be indicated, for which we must secure a market. It may also be found that the working capital of wood, an accumulation of capital and interest for centuries as found in the virgin forest, is unnecessarily large, beyond the normal, and hence should, for good business reasons, be as quickly reduced as it can be done profitably, or else if we have to deal with cutover lands we may have to reduce our annual cut, saving gradually enough to first establish the desirable working capital.

Finally, when all these bases for operation are ascertained we may formulate the working plans and decide not only on the quantities to be cut, the operations of improvement required, the manner of conducting the whole management, but also determine in what portions of the property the principal activity is to be exercised during the first ten or twenty years, leaving it to the future manager to modify the plans as experience and changes of condition indicate.

That a well-planned bookkeeping is necessary if we would want to know how our business progresses is self-understood. Not only is it necessary to keep those accounts of financial transactions which any business requires, but each compartment in the forest must be kept account of, with a separate ledger account to show what material it has furnished, what stock remains in it, what operations it has required and whatever position in the general scheme it takes.

A demonstration and experimental area, as the proposed school forest is to be, will, to be sure, entail many operations which in a mere business forest might be dispensed with or delayed to more opportune time. Hence its financial results on the whole may not satisfy the financier. No such experiment, it may be asserted, can be made to demonstrate the profitableness of a business; it can only serve to show methods and their results and to furnish the basis and elements for profit calculations. Nevertheless it is expected that the experiment will pay for itself, while furnishing the desirable object lessons both to the students and timberland owners, the citizens of the State of New York, owners of the great State Park, included.

When this experiment is established, and has demonstrated that rational forest management is possible in this country as well as in the older countries, the constitutional bar will undoubtedly be removed and the entire State holdings placed under proper technical administration, with the students from the State College of Forestry its managers.

B. E. FERNOW.

CORNELL UNIVERSITY.

GEOLOGY AND GEOGRAPHY AT THE AMERICAN ASSOCIATION MEETING.

II.

14. *Another Episode in the History of Niagara River.* By J. W. SPENCER, Washington, D. C. This paper is a sequel to one read before the American Association four years ago, on the duration of Niagara Falls. It announces the discovery that while the falls were receding from Foster's flats to the locality of the railway bridges the fall of the river reached its maximum of 420 feet by the retreat of the Ontario waters to the north. The return to the present amount of 326 feet was interrupted by the rising of the level of the lake in the gorge to a height of 75 feet above its present level, thus reducing the actual fall of the river to 250 feet. The evidence of this is preserved in the remains of a terrace deposit opposite the foot of Foster's flats and

a corresponding terrace just outside the mouth of the gorge; and these terraces, with other parts of the shore line in the Ontario basin which marks the rise of the waters so as to flood the Niagara gorge, are here named the Niagara strand. The rising of the waters was occasioned by the lifting of the barrier at the outlet of Lake Ontario to an elevation 100 feet higher than now. By the subsequent erosion of this barrier, which was partly composed of drift, the actual fall of the Niagara waters has been increased to its present figure. The reduction of the descent of the river is found to be sufficient to account for the shallowness of the channel at the Whirlpool rapids. The narrowing of this section is explained by the fact that the youthful Niagara took possession of a small preglacial valley there, giving greater depth to the river. It is further probable that the volume of the river was less at that time, since it is supposed that a portion of the outflow of the Great Lakes then passed to the Mississippi.

15. *The Age of Niagara Falls as Indicated by the Erosion at the Mouth of the Gorge.* By Professor G. Frederick Wright, Oberlin, Ohio. The late Dr. James Hall early noted the significant fact that "the outlet of the chasm below Niagara Falls is scarcely wider than elsewhere along its course." Clearly this is important evidence of the late date of its origin, and it has been used by the author and others in support of the short estimates which have been made concerning the length of time separating us from the Glacial period. A close examination made by the author this summer greatly strengthens the force of the argument, since he found that the disintegrating forces tending to enlarge the outlet and give it a V-shape are more rapid than has been supposed. The depth of the gorge at the outlet, from the top of the Niagara limestone to the river, is 340 feet. The thickness of that formation of limestone at the surface is here, however, only about 40 feet; while the soft Niagara shales underlying it are from 60 to 75 feet thick. Below there is a stratum of Clinton limestone 30 feet in thickness, and below that a shaly deposit of 70 feet. The Niagara shales at this point have never been covered by talus, so that they have always been accessible to disintegration by atmospheric agencies.

Somewhat over forty years ago a railroad was built along the face of the eastern side of the gorge, affording an opportunity to observe the rate of disintegration. All along where a perpendicular exposure was made, the shale has crumbled away to an extent of several feet, and in some places to that of 20 feet. A conservative estimate of the rate of disintegration for the 70 feet of Niagara shales supporting the Niagara limestone would be one inch a year, with a probable rate of two inches a year. But at the lowest estimate no more than 12,000 years would be required for the enlargement of the upper part of the mouth of the gorge 1,000 feet on each side, which is very largely in excess of the actual amount of enlargement. Some of the recent estimates, therefore, which would make the gorge from 30,000 to 40,000 years old, are evidently extravagant, and must incorporate some error in their premises. The age of the gorge cannot be much more than 10,000 years, and is probably considerably less.

16. *A Recently Discovered Cave of Celestite Crystals at Put-in-Bay, Ohio.* By Professor G. Frederick Wright. The principal locality in America from which museums have been supplied with specimens of celestite (sulphate of strontium) is Strontian Island, two or three miles from Put-in-Bay Island, in the western end of lake Erie. Just as this supply was becoming exhausted, a remarkable fissure was discovered last winter on Put-in-Bay Island, which is completely surrounded with very large crystals

of this beautiful mineral. The fissure was penetrated in digging a well seventeen feet below the surface, and is large enough to permit the entrance of ten or twelve people at a time. It is not an ordinary cavern, but apparently is the interior of an immense 'geode' lined with celestite crystals. The geological formation in which it occurs is the Waterlime of the Lower Helderberg. Large deposits of gypsum occur in the vicinity.

17. *Geography and Resources of the Siberian Island of Sakhalin.* By PROFESSOR BENJAMIN HOWARD, London, England. Sakhalin has a length of about 670 miles and a breadth of 20 to 150 miles. The features which the author observed during his visits to this island in 1890 and 1896, as here described, are (1) the absence of natural harbors and reliable anchorages around its entire 1,500 miles of coast, and the reasons for it; (2) the contrast which this island, having no volcanoes, exhibits as compared with the volcanic chain of the whole Japanese group and its continuation in the volcanoes of Kamtchatka; (3) the contradiction which Sakhalin, possessing an almost subarctic climate, affords to the popular belief that latitude is the dominant factor in the determination of climates; (4) its mineral resources, especially coal and iron; (5) the immensity and density of the fish shoals in the neighboring waters; (6) the absence of navigable rivers; (7) the persistence of unadulterated life and manners in the aboriginal Ainos there as when described nearly three thousand years ago by the oldest Japanese historian; (8) the vast numbers of medusæ (jelly-fish) along the southern coast, and the marvelous phosphorescence of the sea as witnessed by the author; (9) the strategic value of the island to Russia; (10) the completeness of its adaptation to its present use as a penal stronghold; (11) the present development of its agricultural and mineral resources, and its prospective self-maintenance chiefly from its future fishing industries; and (12) the expediency of maintaining the spelling of the name Sakhalin, as here used.

18. *Evidence of Recent Great Elevation of New England.* By J. W. SPENCER, Washington, D. C. This paper was a description of the valley terraces in mountainous parts of New England, illustrated by sections showing that the declivities of the valleys are not by even slopes, but by a succession of steps, the plains of which become terraces farther down the valley. These steps are regarded as gradation plains in the changes of the baselevel of erosion, and many of the corresponding terraces are hundreds of feet above the floors of the valleys. From these features it is inferred that the recent rise of the mountainous region can be approximately measured by the sum of the heights of the steps. Yet it is not inferred that the elevation need to have been from below the sea level; and consequently the gravels are not claimed to have been necessarily of marine origin.

19. *The Oldest Palæozoic Fauna.* By G. F. MATTHEW, St. John, N. B. This fauna is contained in a series of beds unconformably underlying the Cambrian system in eastern Canada and Newfoundland. The base of the Cambrian in the former country is marked by a barren sandstone, and in the latter by conglomerates. Erosion of the lower terrane continued up to and included the time of the Paradoxides fauna. The relation of these two terranes is comparable to that of the Upper and Lower Silurian in New York, or the Carboniferous and Subcarboniferous in eastern Canada. The fauna known consists of about twenty species. It contains no trilobites either in eastern Canada or Newfoundland. Various forms of the family Hyolithidæ are the dominant types. Other gastropods allied to Capulus and Platyceras occur; also brachiopods; remains of echinoderms (cys-

tids?); and corals allied to Archæocyathus and Dictyocyathus. The thin limestones which occur in the upper half of the terrane are supposed to have originated chiefly from foraminifera (Globigerina, etc.).

20. *The Oldest Known Rock.* By Professor N. H. Winchell, Minneapolis, Minn. With a brief description of the other members of the Archean series as made out by the Geological Survey of Minnesota, this paper more particularly described the so-called greenstones of this State, which the author considers the bottom of the Archean scale and the representative of the original crust of the earth formed from the molten mass by the earliest consolidation. The greenstones are divisible into two parts, one igneous and the other clastic, the latter succeeding the former with a confused and apparently sometimes non-conformable superposition, somewhat as surface eruptive rocks might be superposed, in the presence of oceanic action, upon a massive of the same nature at the same place. The clastic portions of the greenstones vary to more silicious rocks, constituting great thicknesses of graywackes, phyllites and conglomerates; and as such they have been converted by widespread metamorphism into mica schists and gneisses, the alteration coming on by degrees, increasing in intensity toward centers of granitic intrusion and toward the great areas of granite and igneous gneiss.

Such granite and such metamorphic rocks, as a whole, have been considered the basement rock, the oldest known rocks of the country. But, following up the long known fact that the Laurentian granite and igneous gneisses cut the schists and sedimentary gneisses and hence are younger, they are thus shown to be younger also than the bottom greenstones. They occasionally penetrate these greenstones and change them to amphibolyte and pyroxene gneiss. These metamorphic schists and gneisses seem to be a representative of the sedimentary portion of the Lower Laurentian of Canada, while the igneous granite and gneisses are as plainly a general parallel of the igneous portion of that series. It follows, therefore, that the Canadian Laurentian is, as a whole, of later date than the greenstones, if the succession is the same as in the Northwest, and that the greenstones should be considered the bottom rock of the geological scale.

21. *The Origin of the Archean Igneous Rocks.* By N. H. Winchell. The greenstones, which were discussed in the preceding paper, are supposed to represent the primeval crust of the earth. The author denies the possibility of the derivation of the alkaline magma from these ferro-magnesian rocks by any of the methods of lixiviation or of differentiation which are currently proposed by geologists who have lately discussed the origin of the igneous rocks. Accepting this ferro-magnesian crust as the rock of the first magma of the earth, the author shows that it could not give rise to minerals consisting largely of a potash base, such as orthoclase and microcline, which constitute the greatest distinguishing element in the alkaline magma. Neither could it give rise to the preponderating percentage of silica which accompanies the potash minerals. These characters, therefore, must have some other source. The potash is believed to have existed in the ocean itself which immediately followed the consolidation of the first crust. Such an alkaline ocean, especially if heated, would hold in solution much silica. Hence followed the precipitation of alkaline silicates, and of excess of silica; hence, also, the alkaline character of the schists and gneisses when its sediments were formed into rock and metamorphosed; and hence, when fused, the alkaline magma. As to the cause of this potassic ocean by which the great stock of the world's potash was

stored in the Archean rocks, the author does not attempt any explanation, further than to suggest that possibly, owing to the chemical characteristics of potassium, it remained in the earth's atmosphere until the consolidation and also the cooling of the first crust sufficiently to allow the ocean to rest upon it, and that it was then rapidly extracted by the moist, heavy atmosphere that prevailed, being carried into the sea.

22. *Joints in Rocks.* By PROFESSOR C. R. VAN HISE, Madison, Wis. (Read by title.)

23. *Notes on Some European Museums.* By DR. E. O. HOVEY, American Museum of Natural History, New York City. Relating to museum administration and methods of display, as observed in Europe; published in the *American Naturalist*.

24. *History of the Blue Hills Complex.* By PROFESSOR W. O. CROSBY, Boston, Mass. Relating to the tract of the Blue Hills, on the southern border of the Boston basin. (Read by title.)

25. *Paleontology of the Cambrian Terranes of the Boston Basin.* By AMADEUS W. GRABAU, Boston, Mass. The Lower Cambrian rocks are found to contain fossils at Nahant, Mill Cove, Rowley, Topsfield and Jeffreys Ledge. The last three localities were discovered by Mr. J. H. Sears, who was also the first discoverer of fossils at Nahant (1887). From collections made by him at Nahant seven species have been identified, including four of Hyolithes. The fossils detected in the rocks of the other localities consist of indeterminate sections of Hyolithes and a cross section of a trilobite from Mill Cove. From pebbles and boulders found at Nahant and Cohasset by Mr. T. A. Watson, a large number of Lower Cambrian fossils have been obtained, representing fifteen species. The Middle Cambrian of Hayward's Creek, South Braintree, contains the large *Paradoxides harlani*, *Agraulus quadrangularis* and several other forms. The Upper Cambrian is represented in this district only by erratics containing *Lingula* and *Scolithus*.

26. *Diamonds in Meteorites.* By MRS. E. M. SOUVIELLE, Jacksonville, Fla.

27. *The Periodic Variations of Glaciers.* By PROFESSOR HARRY F. REID, Baltimore, Md. (Read by title.) The *Journal of Geology* for July-August (Vol. VI., pp. 473–476) contains an article by Professor Reid on this subject, giving records for Europe, Asia and Greenland in 1896 and for the United States in 1897. A general retreat of the glaciers is noted, excepting slight tendency to advance in Greenland.

28. *Notes on the Occurrence of Tourmalines in California.* By C. R. ORCUTT, San Diego, Cal. Near San Diego an enormous bed or vein of lepidolite (lithia mica), 60 feet or more in width where best exposed, contains rubellite (pink tourmaline) in large amounts. As a source of lithia and potash this deposit must soon take first rank commercially. It is now being worked as an open quarry, and 1,500,000 tons are estimated to be available. Much of the rubellite has been distributed to museums. Tourmalines of gem quality were first found during the present year, being all of the red variety. Black tourmalines are frequent, but green tourmalines occur only sparingly, at this locality.

29. *The Agassiz Geological Explorations in the West Indies.* By ROBERT T. HILL, Washington, D. C. This paper, which, with several preceding, was presented in Cambridge on Friday forenoon in the Museum of Comparative Zoology (largely founded through the labors and munificence of Louis Agassiz and his son, Professor Alexander Agassiz), described briefly the expeditions made during recent years by Alexander Agassiz, with his assistants, for observations in zoology and geology, on sea and land, in the West Indies and on the Isthmus of Panama. Within Late Tertiary and Quaternary time many parts of this region have undergone

great epeirogenic movements, perhaps more interesting than those of any other part of the world in such late geologic periods.

Dr. J. F. Whiteaves, Paleontologist of the Canadian Geological Survey, Ottawa, Canada, was elected to be the Vice-President for Section E, and Professor Arthur Hollick, of Columbia University, New York City, to be its Secretary, in the Association meeting at Columbus, Ohio, next year. Geology is also represented in the election of Professor Edward Orton, of Columbus, to be the President of that meeting.

Warren Upham,
Secretary of Section E, 1898.

NOTES ON INORGANIC CHEMISTRY.

The presidential address of Sir William Crookes before the British Association at Bristol this year was concerned with two themes. The first of these was the world's wheat supply and how it can be increased. Not only is Great Britain unable to raise her own wheat supply, but the wheat-producing area of the world is being so rapidly taken up that by 1931 the world will be unable to raise enough for consumption, and the immediate prospect will be a wheat famine. This can be obviated only by increasing the wheat crop per acre, that is by using fertilizers to a much greater extent than is at present the case. The chief fertilizer needed is combined nitrogen. The Chili saltpeter now extensively used is brought from northern Chili, but if used on all wheat land, the supply from the Chili mines would be exhausted in a very few years. Cultures of bacteria which assimilate atmospheric nitrogen have been tried as a fertilizer, but thus far with little success. The great desideratum is a process for the manufacture of sodium nitrate directly from the nitrogen of the air. With an indefinite supply of fertilizer the world's wheat yield can be doubled with little increase of acreage. This would tide matters over till the latter part of the twentieth century, when it may be hoped that the luxuriant vegetable growth of the tropics will be utilized for food supply. At all events, the wheat famine would be postponed till the present generation has disappeared from active work. It may not prove impossible to solve the problem of 'fixing' atmospheric nitrogen even at the present time. In 1892 Professor Crookes exhibited at a Soirée of the Royal Society an experiment on the 'Flame of Burning Nitrogen.' Nitrogen will burn in oxygen if the heat of the ignition point can be maintained. This can be done by the electric current, and it is calculated, that by utilizing the energy of Niagara for electricity, sodium nitrate can be manufactured at a cost of not over $25 per ton—less than its present price. This figure would probably be reduced were the operations carried on on a large scale. The amount of nitrate needed for fertilizing the whole possible wheat acreage of the world would be twelve millions of tons annually; Niagara could furnish the electrical energy for the manufacture of this without sensibly diminishing its flow.

The second part of Professor Crookes' address was devoted to recent developments in chemistry and electricity. Dewar's liquefaction of hydrogen and the consequent low temperature work; Ramsay's discoveries of krypton, neon and metargon; Nasini's discovery of coronium in the volcanic gases at Pozzuoli; Marconi's application of Hertz's discovery to telegraphy without wires; Zeeman's phenomenon and the possible light it may throw on the ether; the theory of the Röntgen rays and their nature; a possible theory for the Becquerel rays emitted from uranium and its compounds, and the allied rays from thorium, and Curie's newly discovered polonium—these were all considered, and then the announcement made of a new

element discovered by Professor Crookes among the rare earths. To this the name monium is given; it was discovered by spectro-photography, its lines standing almost at the extreme end of the ultra-violet rays, and hence only visible on the photographic plate. Its atomic weight is apparently about 118. The address concluded with a short reference to the work of the Society of Psychical Research of which also Professor Crookes is President.

J. L. H.

CURRENT NOTES ON METEOROLOGY.

THE MEAN ANNUAL RAINFALL OF THE GLOBE.

IN the *American Journal of Science* for January, 1882, Loomis published the first chart of the mean annual rainfall of the globe, which has, since then, remained the accepted standard of the world. The annual amounts of rainfall were divided into five groups, and the chart was colored in five shades of blue to indicate rainfalls of (I) less than 10 inches, (II) 10 to 25 inches, (III) 25 to 50 inches, (IV) 50 to 75 inches, and (V) over 75 inches. The data at Loomis' disposal were far from complete. A revised edition of the map was published in 1889, the classification of the rainfalls remaining the same, but five different colors being used to indicate these classes, instead of the five shades of blue employed on the original map. During the years that have elapsed since Loomis' map was published, there has been a large increase in the number of rainfall observations from all parts of the world, and the vast body of material now available has been utilized by Supan in the construction of new rainfall maps. Supan's first publication, 'Die Vertheilung des Niederschlages auf der festen Erdoberfläche,' appeared a few months since (Ergänzungsheft No. 124, Petermann's Mittheilungen), and his second, 'Die jährlichen Niederschlagsmengen auf den Meeren,' has just appeared in the same journal (VIII, 1898, pp, 179–182). These articles are of great value. They give us revised charts of the mean annual and the seasonal rainfall over the lands, and also the first chart that has ever been published of the mean annual rainfall over the oceans. These are all based on the latest and best data obtainable, and will doubtless remain the standards for many years. The varying amounts of rainfall, grouped into six classes, are indicated by different colors, the heaviest rainfall being shown in blue, and the lightest in yellow.

SYMONS' BRITISH RAINFALL.

MR. SYMONS' annual volume on 'British Rainfall' for 1897 contains a noteworthy article on the 'Mean Annual Rainfall in the English Lake District,' which is a continuation of articles on the rainfall of parts of the same region, published in the volumes for 1895 and 1896. The area under discussion in the present paper embraces about 650 square miles. Records from 147 stations have been utilized, and the aggregate number of yearly records dealt with is 1,612. Two maps accompany the article, an excellent orographical map of the Lake district, and a map showing the mean annual rainfall of the district. Mr. Symons now has 3,318 rainfall observers, truly an imposing number in the little territory of the British Isles, and a body of workers which, under able leadership, is gathering a most valuable store of material. And this material, be it said, is being constantly put to use.

NOTES.

THE annual report on the 'Rainfall in South Australia and the Northern Territory in 1896,' by Sir Charles Todd, Government Astronomer of South Australia, contains an account of the great 'heat wave' of January, 1896. This 'heat wave' was one of exceptional severity. At Gundabooka Sta-

tion, on the River Darling, the mean temperature for twenty-four days, from January 1 to January 25, was 120° in the shade. The cause of the protracted hot spell was the persistence of monsoonal conditions over the interior during the month, with weak gradients and light winds, there being no depressions of sufficient energy to drive the cool southerly winds inland.

The seventh annual bibliographical number (for 1897) of the *Annales de Géographie* contains the usual short notes on climatological and meteorological publications issued during that year.

R. DeC. Ward.

Harvard University.

CURRENT NOTES ON ANTHROPOLOGY.

ON INSPIRATION.

The curious phenomenon of trance, voluntary or involuntary, plays the leading rôle in the ethnology of religions. In it all faiths have their origins, and by it most are sustained. A phase of it is known to psychologists as 'suggestion,' but this does not exhaust its aspects. Undoubtedly, both a physiology and a philosophy lie behind its superficial manifestations.

Some striking examples of it among the Slavic peoples are given in the 'Archiv für Religionswissenschaft' (Bd. I., Heft, 3) by Dr. Krauss, of Vienna. They are not surpassed by the Yogin of India or the high-priest of Nagualism, and have been studied by scientific observers.

That wholly exceptional, really inexplicable physical powers are obtained in the 'Yogâ' none can deny; and that equally anomalous psychical faculties are developed under its influence is just as certain. We still await a sympathetic, clear, unbiased study of this pregnant topic.

RELICS FROM THE ULOA VALLEY.

The Uloa Valley opens into the Gulf of Honduras about Puerto Cortes. Attention was first directed to its archæological remains about 1888 by a German planter, Mr. E. Wittkugel, who opened a number of mounds and made a large collection of pottery, etc. In 1896 and 1897 Mr. George Byron Gordon conducted explorations there under the direction of the Peabody Museum, Cambridge. His results have appeared in the Memoirs of the Museum, Vol. I., Nos. 4 and 5. It is amply illustrated, and presents a clear and succinct narrative of the work. The art-remains plainly show the influence of Mayan culture; but there is a residuum which, in the opinion of both Professor Putnam and Dr. Seler (whose report may be found in the 'Verhand. der Berliner Anthrop. Gesell.' 1898, p. 133), should be assigned to some other people.

In the same cover with Mr. Gordon's report on the Uloa Valley is his brief statement about cave exploration near Copan. The results were somewhat negative, not indicating extreme antiquity, though signs of a special art-development were not wanting.

D. G. Brinton.

University of Pennsylvania.

SCIENTIFIC NOTES AND NEWS.

A price-list of the reprints of the papers of the late Professor E. D. Cope has been drawn up, and can be secured from Mrs. E. D. Cope, Haverford College, Haverford, Pa. Owing to Professor Cope's method of work and untimely death many of his important contributions to science exist only in these reprints, and the list should be secured by all those interested in paleontology, zoology and psychology.

We are sorry to learn that the editor of *Natural Science* feels compelled to discontinue the editing of the journal after December. He is prepared to hand it over to any competent man of science who will relieve him of all responsibility and continue it as an independent journal. Students of the natural sciences are under very great obligations to the editor of *Natural Science*, whose desire to remain anonymous during the continuance of the journal

should be respected, for conducting through thirteen volumes a journal that has always proved interesting, independent and profitable. It is to be hoped that arrangements can be made for the continuation of *Natural Science* on the same general lines as at present.

PROFESSOR BEHRING has replied, in the *Deutsche Medicinische Wochenschrift*, to those who have criticised his action in securing in the United States a patent for his antitoxin. He states that he is no longer a physician and that it is necessary to adopt business methods to secure money to proceed with his investigations. He further states that his manufacturers will supply the antitoxin in America at the same price as hitherto and in a more reliable form. The question as to how far men of science should patent their discoveries is evidently one of great difficulty, but the case of Professor Behring is complicated by the fact that he was not the sole discoverer of the antitoxin treatment of diphtheria.

THE Board of Trustees of the University of Pennsylvania, at their monthly meeting on October 5th, appointed a committee to arrange a memorial meeting in honor of the late Provost Pepper. Other institutions with which Dr. Pepper was connected will be invited to take part in the meeting.

WE regret to record the death of M. Gabriel de Mortillet, the eminent anthropologist. He was born at Meylan (Isère) in 1821. After holding positions in the museums of Geneva and elsewhere, he organized the prehistoric section of the Paris Universal Exposition of 1867. A year later he was appointed curator of the Museum of Antiquities at St. Germain. He was at one time a member of the French House of Deputies, being an extreme radical. His anthropological publications are numerous and important.

WE regret also to record the death of Mr. William Wilson, a distinguished railway engineer, in London on September 28th; of Dr. Charles L. Fox, bacteriologist of the Lowell Health Department, and of Dr. David e Toscani, professor of legal medicine in the University of Rome and for twenty years director of the Municipal Office of Hygiene in Rome.

PROVOST HARRISON, of the University of Pennsylvania, has been elected to the presidency of the Wistar Institute of Anatomy, held by the late Dr. William Pepper at the time of his death.

DR. F. M. BRAUER has been appointed curator of the zoological collections at the Royal Museum in Vienna, and M. Albert Gaillard, curator of the Lloyd Herbarium of Angers.

AN archæological map of New York State is in preparation for the Regents of the University, and will be published soon. Hundreds of sites are already described and located, but fuller information is desired, especially along the Hudson River, except in Westchester County. Notes should be sent to Rev. W. M. Beauchamp, Baldwinsville, N. Y., as soon as possible, and should include area and character of site, direction and distance from some village or town, on which side of any large stream or pond, and nature of relics. Full accounts will be prized, but brief notes will often suffice. To insure attention promptness is desired. The Iroquois country is well covered, but the Algonquin much less adequately.

THE Herbarium of the U. S. National Museum has acquired from Dr. W. H. Forwood the collection of plants made by him in western Wyoming in 1881–2.

THE Sixth International Otological Congress will be held in London at the Hall of the Royal Colleges of Physicians and Surgeons, from August 8th to 12th of next year. The last meeting of the Congress was held three years ago at Florence, under the presidency of Professor Grazzi.

THE Central Committee for a Pasteur Institute in India has met at the office of the Director-General, Indian Medical Service, Simla, under the presidency of Surgeon-General Harvey. We learn from the *British Medical Journal* that it was decided that any attempt to start an institution for the sole purpose of antirabic treatment was out of the question, owing to the insufficiency of the funds at the disposal of the Committee, and that the most practical course would be to await the eventual outcome of the proposed Institute of Public Health to be founded by the generosity of the Indian chiefs.

It was, therefore, resolved that the Government of India be asked whether it could give any information as as to when the Chiefs' Institute of Public Health was likely to take practical shape. Until a reply is received nothing definite will be done. Lieutenant-Colonel Roe, Secretary of the Institute, is proceeding on leave, and Major C. J. Bamber has taken up the officiating appointment.

The Rev. E. C. Hallett, British Chaplain at St. Vincent, writes on September 17th last, that the steam barque *Southern Cross*, of Sir George Newnes's Antarctic expedition, called in at St. Vincent on September 13th for the purpose of coaling, when very cordial visits were exchanged between the ship and the shore. Captain Borchgrevink and his staff, who were in excellent spirits, most hospitably afforded the the officials and residents of St. Vincent every opportunity of inspecting the vessel before she started again on the 14th on her voyage to the to the South Polar regions.

A telegram to the daily papers from San Francisco states that Messrs. W. A. Woodruff and C. L. Cleghorn, of Washington, D. C., have sailed for Samoa. They are said to be heading a government expedition to collect rare plants, shrubs and other specimens in the interior of the Samoan Islands.

The New York *Evening Post* reports that M. Viger, French Minister of Agriculture, has delegated M. d'Anvina, an engineer, and MM. Dubray and Minotier, to come to this country to study the American machinery and tools used in the manufacture of flour, and to ascertain their prices and the cost of transportation to France.

Herr G. Witt, of the Urania Observatory, Berlin, has made an important discovery while searching photographically for minor planets. On August 14th last he found, says *Nature*, on the plate he had exposed, in addition to the trail of the minor planet he was hoping to catch, a second trail which indicated the presence of another of these small bodies moving round the sun with a more than usual velocity. Herr Witt was not content, however, to let the matter rest thus, so he undertook a series of eye observations and measurements which are necessary for the determination of the elements of the body in question. Herr Berberich undertook the task of investigating its motion from these observations, and the result, as far as is known, is surprisingly interesting. Instead of the object being a new or a previously observed member of that system of bodies which travels round the sun between Mars and Jupiter, it proves to be quite an exception, its orbit lying *within* that of Mars; in other words, it travels in a path which is nearer to the earth than that of Mars. It completes its revolution in a period of about 600 days; that is, roughly, 80 days less than Mars takes; both the eccentricity and inclination of the orbit are considerable. This small body thus becomes our nearest neighbor after the moon, and, although small, will shine when closest to us as a star of the sixth magnitude. No doubt the discovery of this new planet will incite afresh observers of these small bodies; and who will say that this new object is the only member of its kind that performs its revolution round the sun in an orbit between the earth and Mars?

Dr. Florentino Ameghino has made a remarkable discovery, an account of which we take from *Natural Science*. Details of a nocturnal quadruped have been brought to him from time to time by the Indians, and a few years ago the late Ramon Lista actually saw and shot at a mysterious creature in the interior of Santa Cruz. Apparently bullet-proof, it disappeared into the brushwood, and all search for it proved futile. Lista described the creature as a pangolin, without scales and covered with reddish hair. Despite the fact that Lista was known to be a good observer, Dr. Ameghino could not help feeling that he was deceived. Lista, however, has now been proved correct, for Ameghino received recently from South Patagonia some fresh bony ossicles and a partially destroyed skin. The ossicles were comparable to those of *Mylodon*, but smaller, and they were embedded in the skin, like 'paving stones in a street.' The skin itself is two cm. thick, and of such toughness that it could only be cut with a hatchet. The surface of the skin itself shows an epidermis, not scaly at all, but covered with coarse hair, four to five cm. in length, and of a reddish gray shade. This

Ameghino considers was the animal described by Lista, and as that naturalist unfortunately lost his life while exploring Pilcomayo, and was the only civilized man who had seen it in the flesh, he names it *Neomylodon listai*. The importance of the discovery need not be emphasized here.

PROFESSOR KOCH, with his assistants, Professor Kossel and Dr. Pfeiffer, is, says the *British Medical Journal*, at present in Rome studying the malarial question in all its aspects. The Italian government has placed the state laboratories at his disposal, and the Minister of the Interior entrusted Professor Santiliquido, the head of the laboratories, to welcome him on behalf of the government. Permission has also been granted him to study the cases of malaria admitted into the military hospital and into the hospital of Santo Spirito. Professor Koch has found only a small number of cases of malarial fever in these institutions, particularly in the military hospital, although September as a rule is the month in the year when the greatest number of cases of malaria are received in the hospitals from the Roman Campagna. Professor Koch and his assistants work daily in the laboratory of the Sancto Spirito hospital, and they make occasional visits to the most malarial districts around the city. He has stated that he was led to study malaria in Italy because the Italian school had written and investigated much about it, and the views of the leaders differ so much in many important points that he was anxious to come to a definite conclusion on the whole subject, if possible. In discussing Ross's work in India in connection with Manson's mosquito theory, he spoke in the highest terms of Ross's investigation. Professor Koch intends to leave Rome about the end of September, when he and his assistants most probably will go to Greece to continue their malarial studies in that country.

THE report of the Keeper of the Manchester Museum, says *Natural Science*, refers to the installation of electric light, which has been rendered possible by the generosity of Mr. Reuben Spencer, who contributed £500 to the expense. The Museum is at present in the hands of the painters, and it is to be hoped that the committee will sanction the general whitening of the ceilings asked for by Mr. Hoyle, in order that the electric light may have a good start. Professor Hickson has been doing good work on the plankton of Lake Bessenthwaite, and some of the rarer forms will shortly be placed on exhibition. Miss Nördlinger, the keeper's secretary, has taken entire charge of the library. The committee have undertaken the printing of Mr. Sherborn's index to the 10th and 12th editions of the 'Systema Naturæ' of Linnæus, which should prove of value to zoologists, as these books form the starting-point of zoological nomenclature. A series of lectures will be delivered by Professor Boyd Dawkins on certain Saturdays and Sundays between October and June, and other lectures will be delivered by the staff as usual. Mr. Hoyle closes his report with an appeal for more funds, Manchester spending only £2,785 a year on its Museum, while Liverpool spends £5,700.

THE *Scientific American* gives the following statement of space at the Paris Exposition of 1900 as arranged by the Commissioner-General, Mr. F. W. Peck :

	Sq. ft.
Agriculture and food products	20,000
Army and navy	3,300
Chemical industries	5,160
Education, instruments, practical sciences, and arts	11,470
Fine arts	(not yet known)
Forestry, hunting and fisheries	3,300
Heating apparatus	4,500
Horticulture	(not yet known)
Machinery and electricity	50,000
Manufactures	25,000
Mines and mining	7,700
Textiles	13,000
Transportation and civil engineering	20,000
Total	163,430

IT has been decided, as we learn from the London *Times*, to hold an exhibition in Coolgardie next year, and the government of Western Australia has resolved substantially to support the undertaking by a money and land grant. The proposal has been warmly taken up by the people of Western Australia, by whom a representative executive commission has been elected. The original proposition was

to hold a mining machinery exhibition, and to open the same in October, 1897, but the proposal received so much support in the colony, and was responded to so freely by manufacturers in all parts of the world, that it became necessary to fix upon a later date, and to make the exhibition more comprehensive. The scope of the exhibition was therefore enlarged, and it was determined to call it the Western Australian International Mining and Industrial Exhibition, the objects of which should be to obtain the fullest and best possible display of mining and other machinery, and of all kinds of manufactures suited to the requirements of the mining, timber and agricultural industries of the colony, and to its growing population, in order generally to promote and foster industry, science and art, to encourage invention, and to stimulate commerce in the goldfields and throughout the colony.

THE Commissioners of Fisheries, Game and Forest, of the State of New York, have issued their Second Annual Report. Nearly 200,000,000 fish were placed in public waters upon the application of local authorities. Atlantic salmon fry and yearlings, American brook trout (*Salmo fontinalis*), rainbow trout (*Salmo irideus*), Sunapee trout, Swiss lake trout obtained from the Swiss government, and Labrador whitefish, are among the species introduced, and in addition various streams and lakes have been stocked with different forms of fish food. The report contains articles by Professor J. D. Quackenbos, on the American saibling, a member of the Salmonidæ, which has only recently attracted attention; by Mr. G. W. Rafter, on stream-flow in relation to forests; by Mr. Surface, on the game birds of the State, and other matters of scientific interest.

THE U. S. Fish Commissioner has presented to Cornell University a collection of fresh-water and salt-water fishes, numbering between four and five hundred thousand specimens. The collection, in so far as it consists of living fishes, will be of great value not only to the zoological department, but also to the College of Forestry, in which a course in pisciculture and venery is to be introduced. It is understood that duplicates of this collection are to be presented to other institutions.

UNIVERSITY AND EDUCATIONAL NEWS.

THE will of the late Col. Joseph M. Bennett, who during his life-time had made generous gifts to the University of Pennsylvania, leaves to the University property valued at $400,000. The money is to be used for the higher education of women.

A SUM of money, said in the daily papers to be $158,000, has been given by friends of Barnard College to pay the entire indebtedness of the College due to its removal to the new site adjacent to Columbia University.

A DONOR whose name is withheld has given Wellesley College an astronomical observatory and a telescope, said to be of large size.

VASSAR COLLEGE receives $10,000 by the will of the late Adolf Sutro, of San Francisco. The same College has been given $1,000 by Senator Coleman, of Michigan, the income to be used to purchase books and instruments for the astronomical observatory.

THE estimates of the Navy Department for the ensuing year include $2,120,000 for the reconstruction of the Naval School at Annapolis.

THE annual report of President Low was presented to the Trustees of Columbia College on September 24th. During the year the University received $346,409 for permanent endowment and $43,909 for current uses. President Low urges the building of dormitories, both upon the grounds of the University and adjacent to them. The following account is given of the cost for land, buildings and equipment of the new site:

Cost of land.....	$2,000,000 00	
Legal expenses	3,637 95	
		$2,003,637 95
Library:		
Construction.....	1,100,542 09	
Equipment	97,037 38	
		1,197,579 47
Schermerhorn Hall:		
Construction.....	457,658 17	
Equipment	35,786 35	
		493,444 52
Fayerweather Hall:		
Construction	274,113 67	
Equipment	14,645 43	
		288,759 10

Havemeyer Hall:		
Construction.....	$516,488 62	
Equipment.....	53,474 86	
		$569,963 48
Engineering Building:		
Construction.....	284,075 50	
Equipment.....	20,325 47	
		304,400 97
University Building:		
Construction.....	842,887 85	
Equipment of power-house and connections.....	115,578 52	
Equipment of gymnasium.....	39,399 24	
		997,865 61
Vaults:		
East..	30,382 79	
West.....	37,316 40	
		67,699 19
Old buildings—Repairs and equipment:		
West Building.....	10,252 67	
College Hall.....	5,113 34	
		15,366 01
Insurance.....		3,754 40
Outside street work.....		133,367 81
Improvement of grounds and incidentals.....		403,373 75
Expenses of removal.....		59,987 56
Interest.....		339,812 08
Total.....		$6,879,011 90

AT Columbia University Mr. J. H. McGregor has been appointed assistant in zoology; Mr. S. O. Miller, assistant in mechanical engineering, and Messrs. F. S. Hyde, E. J. Riederer and Victor Linher assistants in analytical chemistry.

MISS ROXANA H. VIVIAN has been given the Alumnæ fellowship for women in mathematics at the University of Pennsylvania, and Mr. H. B. Alexander, a Harrison fellowship in philosophy.

THE Hon. John McGregor has given £500 to the fund for the endowment of a chair of forestry in the University of Edinburgh.

DR. FERDINAND FISCHER, of Göttingen, has been promoted to an associate professorship of chemistry. Dr. O. Seeliger, of Berlin, has been appointed professor of zoology in Rostock and Dr. Haussner professor of mathematics at Giessen. Dr. Lorenz and Dr. Keller, of the Polytechnic Institute at Zurich, have been appointed to full professorships of electro-chemistry and zoology, respectively.

DISCUSSION AND CORRESPONDENCE.

THE METHOD OF TYPES.

IN discussing the outlook for stability in generic nomenclature* the method of types has been contrasted with what might be called the method of concepts. The notion of the individual naturalist regarding a certain genus at any particular time is, of course, conceptual, but with increasing knowledge this concept is subject to frequent change resulting commonly in nomenclatorial confusion. With the older naturalists each concept was given a distinct name, while modern practice is less logical in employing a single designation for numerous and varying ideas, to the great detriment of systematic study, since the definite location of genera is rendered theoretically impossible.

The method of concepts originated in the days of mediæval scholasticism, when abstractions commanded great respect and were the subjects of careful study. It was based on the doctrine of the separate creation of species and logically comported with that view of nature. A genus could not be more than an abstraction under a belief which held, in last analysis, that the most similar species were equally distinct with the most diverse. Not only were genera thus assailable, but destructive criticism threatened even the specific idea, as witness certain applications of the oft-quoted assertion of Goethe: 'Nature knows only the individual.' While such ideas obtained, classification could have no logical sanction, its only utility being that of an index giving access to names and descriptions. A system which could do this with the least effort and the greatest dispatch became popular because its users enjoyed a sense of rapidly-expanding knowledge, and much convenience was afforded collectors who preferred their specimens with names. In the manufacture of classifications for this purpose adroit statement often proved more successful than careful study or deep insight. The problem was, indeed, entirely conceptual, the most diverse facts becoming of identical significance if they could be covered by the same formal statement. The resulting conventionalized ideas still figure largely as 'characters,' so that many

* SCIENCE, August 12, 1898, pp.

existing systems of classifications are simply card houses of abstractions.

Whatever doubt may yet remain as to the causes and machinery of evolution, the doctrine of the separate creation of species is generally relegated to the past. The causal and genetic relationships previously supposed to affect only individual lines are now ascribed also to genera, families and orders. Systematic biology may not remain an index of names; it becomes an integration of all our knowledge of organic nature. There was introduced an element of finality which broadened all lines of study and suggested new interpretations for every fact and phenomenon, and yet the universal advance which this change of base rendered possible has not caused systematists to reconstruct their science in harmony with prevailing views on the origin, differentiation and distribution of life. In other words, there has been no general or consistent attempt at the application to classification and taxonomy of the pertinent corollaries of evolution.

Instead of an infinite array of disconnected forms and facts, only to be combined in artificial concepts, we may proceed in the study of any group of organisms with the assurance that a truly natural or phylogenic classification is possible, and we have the further satisfaction that such an arrangement when reached will be final and command universal acceptance. The task of the systematist is no longer to study and contrive artful arrangements of concepts, but to gain the clearest possible insight regarding the form, structure and activities of the subjects of his study. All similarities and all differences have value and bearing, not merely those which have been previously used in classification. The deductive method must here, as elsewhere, give place to the inductive. Classification must be built up from below on facts, not suspended from above on abstractions. Affinities must be demonstrated by the production of the connecting links, not inferred from agreement in formal characters. No matter how obscure it may now appear, every species has its history and its relationships, which the naturalist undertakes to discover and to express by his systematic arrangement. He must be ready to accept, record and utilize every new fact and recognize its bearing on the interpretation of other facts. From one group of organisms an extensive series of concepts may be drawn, and these will be successively advanced and thrown aside, the variable element being our knowledge, while the organisms furnish the constants which our notions should gradually approximate. The excellence of the systematist will depend upon his facility in the construction of new concepts in accordance with constantly changing bases of judgment.

Here is the practical issue regarding the method of types. Shall we continue the practice of naming the concept? Shall we not rather think of the name as applied in the most immediate and permanent manner to the organism? We shall thus have a designation ready for the final entity, but also available for any number of approximating concepts which may follow each other with no unnecesary confusion. Successive systems of classification may then be introduced with a minimum of bibliographic labor on the part of the specialist and a minimum of misapprehension for subsequent students. To maintain the use of the method of concepts because systematic biology had a mediæval origin is to stop the dial of progress and decree permanent confusion. And yet this is the purport of the prevalent systems of nomenclature. No existing legislation requires that a genus be anchored to any one point or vicinity. It is not merely a concept, but a negative concept, since it stands at the mercy of all comers, who may dismember at will and and remove any of the species without apology. Certain codes will not permit the sequestration of all the original species, but systematists are not always thus considerate and some do not hesitate to take even the last, though they may avoid injury to the concept and use it later for a second set of species. Such jugglery has done its part toward bringing systematic biology into its present disrepute, for while all workers have not followed counsels of confusion, all are at the mercy of the bigoted and the reckless, and while there are many laws determining trifles of spelling and punctuation, there are as yet none dealing adequately with the weightier matters of clearness and permanence in the application of generic names, nor are there

rational provisions for the incorporation of new facts into systems of classification. At present each of these lays its claim to a finality which all past experience declares elusive.

Under the method of types we shall also be emancipated from the notion that all the species of a genus must of necessity possess a certain character or set of characters, and rational methods of description may be introduced. Natural groups are to be recognized and pointed out not only by means of an absolute agreement among their components, but also from the coherence of the parts. A natural genus may frequently be best distinguished from its neighbors on different sides by different characters, and the attention of the careful naturalist is directed toward the discovery and indication of the separating chasms as of the greatest importance in generic demarcation. Under the method of concepts the existence of genera without absolute definitions cannot be consistently admitted, but the method of types renders their stable designation entirely practicable.

Because it is philosophically true that we know things only from their characteristics, it does not follow that the set of formal characters by which we attempt to describe a generic group need be looked upon as the genus, since genera do not exist because their species agree in the few characters touched upon in the description, but because they agree in all except the superficial or quantitative specific differences. Thus, until a group of organisms is thoroughly known, the work expended on elaborate generic definition is largely wasted, each accession of new forms requiring an extensive readjustment. Under the method of types the energy spent on these temporary contrivances could be applied in the interest of a wider knowledge of the group, and that on a permanent basis. A revision of the genera of an order or family would consist in the thorough description and graphic reproduction of typical species rather than in the rehashing of concepts. Differences between naturalists cannot be expected to cease until knowledge becomes complete, but with the attention directed to the type rather than to the concept there would be the important advantage of a fixed and definite point where all is now uncertain and fleeting. The question of recognition of two related genera would depend on whether the two supposed series or groups of species really stand apart, that is, whether there is a break between them. Nomenclatorially the difficulty is reduced to a minimum. If I recognize one genus the name is A—described in 1820; if two the second is B—described at a later date. If half the effort spent in arranging discarded concepts had been applied to the better description of types our knowledge of genera would be far in advance of the present. The amount of futile labor in systematic biology is appalling, and its practical results are to hamper the naturalist and to close the door of many departments of the science against all who have not a large amount of time for preliminary study of books with little relation to present knowledge or views of classification. Changes of names render the transition from popular to technical literature very difficult, and some considerate systematists have on this account opposed further alterations, even when logically required. Under the method of types it would be possible to select for the illustration of general and popular works species whose systematic standing is of assured permanence.

These are some of the practical benefits which would flow from the application of the method of types, in addition to a nomenclatorial stability out of the question under the method of concepts. Many active systematists are already using various modifications of the suggested method, but its consistent and thorough application under any uniform rule which would eliminate the variable factor of individual judgment, preference or prejudice is apparently barred by the fact that extensive initial changes in nomenclature would be necessary. That many carelessly applied names have escaped into popular use is not, however, a good reason why systematic biology should be kept permanently in its present confusion. The vast majority of names are known, as yet, only to systematists, and the next generation can learn new ones as readily as old, while present workers can well afford an occasional changed designation in consideration of the practical advantages of the method of types.

However, if the specialists in any group can permanently agree among themselves in the designation of the types of genera now recognized, there is no reason why any changes need be made. No new difficulties are, indeed, introduced by these suggestions; but to carry them out would simply bring to definite expression the disagreement and confusion latent among systematists, and make plainer the fact that uniformity and stability stand in inverse ratio to the personal equation; which means that some uniform, and hence arbitrary, method of assigning types for fixing the application of the older generic names will probably be necessary, such as the use of the first designated species.

O. F. Cook.

U. S. National Museum,
September 22, 1898.

THE SUPPOSED BIPOLARITY OF POLAR FAUNAS.

Dr. John Murray, in a recent paper,* again mentions the supposed general likeness of a large number of organismsca ptured in the Antarctic seas to those found in the Arctic seas (p. 133). I should like to say a few words on this topic, since I have paid particular attention to this question, and have repeatedly endeavored to show that in most cases this supposed 'bipolarity' does not exist at all, while in others it is no true bipolarity, cases of true bipolarity being extremely rare.

Especially for the Decapod Crustaceans I have found that "not a single bipolar species is known."† This sentence is quoted by Dr. Murray (l. c.), and he tries to show its incorrectness by mentioning the close resemblance of *Lithodes murrayi* Hend. of the Kerguelen region to *Lithodes maja* (L.) from the North-Atlantic, and by adding that—according to a communication by Mr. Henderson—there is no better illustration of bipolarity than that furnished by the *Lithodidæ*.

I cannot admit these objections, since they are not supported by the facts. We possess a very valuable monograph of the *Lithodidæ* published by Mr. E. L. Bouvier in 1896,* and Mr. Bouvier has shown plainly—as I have maintained previously—that the chief distribution of the *Lithodidæ* is what I have called *meridional distribution;* that is to say, a distribution in the direction North-South, along the western coasts of the continents. It is a true case of false or mistaken bipolarity, a connection of the Arctic and Anarctic range of this family being present along the western coast of America (and perhaps of Africa). Moreover, according to the key of species and the notes given by Mr. Bouvier (l. c. p. 24), *Lithodes maja* is not at all the most closely allied form to *L. murrayi;* but there are two other species which may claim this distinction, namely: *L. tropicalis* A. M. E. and *L. ferox* A. M. E., both from tropical latitudes off the western coast of Africa, where they have been found in depths ranging from 800 to 1100 meters. This fact again suggests a connection from the Arctic to the Antarctic seas along the western coast of Africa, and we see that true bipolarity in the family *Lithodidæ* as well as in the genus *Lithodes* is wholly out of the question.

I cannot understand at all why Dr. Murray again and again calls attention to the supposed bipolarity of the polar faunas as a *striking* feature in zoogeography. Most of the cases introduced formerly as instances illustrating this bipolarity could not be maintained after a critical examination of the respective zoogeographical facts. Thus, among the Decapods this theory finds no support, as I have shown, and likewise the supposed bipolarity of the Holothurians (Théel) does not exist, since Professor H. Ludwig† states that "not a single species of the Antarctic fauna is represented in the Arctic fauna," and that "there is not even a resemblance of both faunas, but a great dissimilarity."

Thus we see that a critical examination lessens the number of the superficially recorded cases of bipolarity, and that my doubts as to the correctness of the bipolarity as a *prime law* or as a *striking feature* of distribution are fully supported, and I am convinced that a careful

*On the annual range of temperature in the surface waters of the Ocean and its relation to other Oceanographical phenomena. *The Geographical Journal*, August, 1898, v., 12, No. 2.

†Zool. Jahrb. Syst., v. 9, 1896, p. 585.

*Ann. Sci. Nat. Zool. (8) v. 1.

†Hamburger Magalhaensische Sammelreise. Holothuriden, 1898, p. 90, f.

investigation in other groups of animals will have the same result. Here I shall add another instance. Dr. Murray (*l. c.*, p. 134) gives a list of bipolar species and genera of fishes (after Günther). Now I took the trouble and tried to verify this list, using the recent publications of Jordan and Evermann* and of Goode and Bean†, but I was very much astonished to find that this list is of no value at all. After having found out that of eleven bipolar species of this list at least *five* are really *not* bipolar, and that of twenty-eight bipolar genera at least *five* are to be dropped, and that *seven* more are very doubtful, I did not think it worth while to examine the whole list, since it is evident by these facts that it is utterly devoid of scientific value.

In order to avoid any misunderstanding, I wish it to be understood that I do not deny the possibility of 'bipolarity,' and, indeed, I have myself established at least *one* instance of true bipolarity of a genus (*Crangon*), and I have given an explanation of it. But I protest most emphatically against the view that bipolarity is a striking character of the marine polar faunas, and I also protest against the introduction of doubtful or poorly established facts or of simply incorrect statements or opinions (cf. *Lithodidæ*) in support of this 'bipolarity' of species or groups.

ARNOLD E. ORTMANN.
PRINCETON UNIVERSITY, September, 1898.

SCIENTIFIC LITERATURE.

Die Zelle und die Gewebe. Grundzüge der allgemeine Anatomie und Physiologie. OSCAR HERTWIG. Jena, Gustav Fischer. 1898. *Zweites Buch. Allgemeine Anatomie und Physiologie der Gewebe.* Pp. viii + 314. 89 figs. Preis, 7 Mark.

The first part of the work, of which this forms the second and concluding volume, appeared in 1892. Its appearance, as the author tells us in the preface, was due to three reasons: first, to impart to a wider circle of readers the views set forth in his university lectures; second, the desire to give to his own investigations; scattered in various periodicals and separate publications, a more comprehensive setting; and third, to crown his 'Lehrbuch der Entwicklungsgeschichte des Menschen und der Wirbelthiere' with more theoretical views, which could not suitably be included there. "But the second part of the book, which includes the subject of the tissues, and which will be about the same size as the first part, will be in a more special sense a completion of the 'Embryology.' For in it, in addition to the description of the tissues, special emphasis will be laid on their origin or histogenesis, and on the physiological causes of tissue-differentiation." The entire work is thus the result of the life-long observations and reflections of one of the most active and successful of modern biologists. It is the product of a true process of growth, and, probably, a final product; for those who have carefully followed the author's writings of the last six years will not find in this volume much not outlined before.

Perhaps the chief significance of the present volume is that it is the first thorough and consistent exposition of Lamarckian principles, as seen in the light of recent embryological work. The leading idea of the entire exposition is the the author's theory of development, which he names *the theory of Biogenesis.* The three foundation stones of this theory are stated in the twentieth chapter to be: (1) Lamarckism, *i. e.*, 'to use Nägeli's expression, the theory of the specific and direct action' of the environment; (2) 'the doctrine of the inheritance of acquired characters, or their transmissibility through the germ-cells to the offspring;' (3) 'the doctrine of the continuity of the process of development, and the principle of progression, that is to say, that development' (both ontogenetic and phylogenetic) 'progresses steadily in a definite direction.'

The first seven chapters are preliminary, dealing with 'the Stages of Individuality,' 'Specific (Artgleiche), symbiotic and parasitic cell-union,' 'On the Methods of Interdependence of the cells of Organisms,' 'The Law of Causation in its Application to the Organism,' 'On the Causes Separating Cell-aggregates into Tissues and Organs,' and the 'Theory of

*The Fishes of North and Middle America, Bull. U. S. Nat. Mus., 47, 1896.

†Oceanic Ichthyology, Mem. Mus. Comp. Zool., v. 22, 1896.

Biogenesis.' A large part of the volume, beginning with the eighth chapter, is taken up with the consideration of the first foundation-stone of the theory of Biogenesis, viz.: specific and direct action of the environment in the individual development. The factors of development are divided into external and internal; the first being defined (p. 75) as 'the different kinds of relationships to the external world with its numerous forces.' The internal factors are of two sorts, viz.: 'the relations of a cell to all other cells of the same aggregate,' and 'the properties and organization of the sexual cells and their derivatives; the internal factors in the stricter sense.' It would seem likely to us to conduce to more clearness if the first subdivision of the internal factors were reckoned as external factors, as, indeed, they are from the standpoint of the organization of the cells. The author discusses this (p. 75), but thinks otherwise.

Under the head of 'External Factors of Organic development' are discussed: gravity; centrifugal force; mechanical effects of traction, pressure and tension; light, temperature, chemical stimuli; more complex stimuli; organic stimuli, such as grafting, transplantation of tissues, reactions between the embryo and mother, and telegony. These subjects are illustrated with many examples drawn from botany and zoology indifferently. Under the head of 'Internal Relations of Organic Development' we have these subjects: the correlations of cells during cleavage; the correlations of organs and tissues in later stages of development and in the adult; chemical correlations; mechanical correlations; the phenomena of regeneration and of heteromorphosis; and, finally, different conditions and modifications of the cells in the adult, such as hypertrophy, atrophy, metaplasy, hyperplasy and necrosis. The mere reading of such a menu is enough to make one's mouth water; but it must be said that most of this part of the volume is pure description; and the facts are set too much in one light, so that the author apparently loses sight, at times, of the importance of the true internal factors contained in the organization of the cell. However, a great quantity of extremely valuable material is here gathered together for the first time, and it would be ungracious to quarrel with the point of view, considering the service to the teacher.

The second foundation-stone of the theory is the doctrine of the inheritance of acquired characters. The chapters which illustrate and attempt to substantiate this theory are, in many respects, the most interesting of the entire volume. It is here that we find a consideration of 'the most important category of causes in the process of development,' viz., the inner factors in the narrower sense. Inheritance depends on continuity; "but the great problem, so differently answered in the various theories, is not the continuity of life as such, which is a fact of experience, but the methods and means by which the continuity on which the persistence of a species depends is handed on from member to member of a series of generations." It is impossible to give here a detailed account of Hertwig's views on the mechanism of the inheritance of acquired characters; but, having rejected the transmission of mutilations and of disease, he sums up thus: "Changes in the entirety of an organism produced by alteration of any function during the life of the individual induce, if lasting, alterations in the cells composing the organism, especially in that substance which we have called the bearer of the characteristics of the species" (that is, the idioplasm contained in the nucleus). "Conditions of the entire organism are thus translated into heritable properties of the cell, in a different material system. The hereditary substance of the organism is thus enriched by a new link, a new possibility, which again becomes manifest in the development of the next generation; thus the new individual now reproduces, to a greater or less extent, from the germ or from inner causes, the properties acquired by the parents in their lifetime through reaction to the environment." He seeks to render the difficulty, of understanding how this translation is possible, less alarming by an analogy, following Hering, between this and the capacity of a nerve-cell to store up impressions and reproduce them again through memory. In both cases the process can be reduced to its most general formula by saying: "External causes exercise influences on a complicated organic

system, which can be stored up in it, and become internal causes, manifesting themselves again, in the sequence, in induced phenomena within the system, for the explanation of which they must be used."

The weakest part of the whole book is the chapter entitled 'Die im Organismus der Zelle enthaltenen Factoren des Entwicklungsprocesses.' For the author, all these factors are included in the nucleus; the protoplasm is isotropic; variation in the size and in the rate of cleavage of the cells are due entirely to the distribution of yolk; and its distribution to gravity. "The accumulation of yolk in the egg-cell undoubtedly exercises a far-reaching influence on the course of development, impressing on it a special character. *On this account* many investigators have been induced to regard the egg as something more than a simple cell," etc. (italics mine). "But the character of the egg as a simple cell is not in the least altered by the accumulation of material in it." Whitman is supposed to hold this idea, that the degree of organization of the egg is proportional to the amount of yolk in it. Such a grotesque conception of Dr. Whitman's views is inexcusable. To say that "the inequalities which arise in the size and the arrangement of the embryonic cells and in their yolk-contents have nothing to do with the differentiation of organs" is simply untrue, as is proved by the whole subject of cell-lineage, which has put the problem here discussed in an entirely new light, about which a voluminous literature has already arisen, but which is not even mentioned by Hertwig. Think of such a phrase as this: 'the organization of the egg, which depends on the inclusion of deutoplasm!' (p. 265).

The third foundation-stone of the theory of Biogenesis is the principle of progression. A single quotation will suffice to indicate what is meant by this: "Placing ourselves upon the theory of descent, might we not suppose that species develop according to the principle of a steady progression regulated by law, like the multicellular organism by epigenesis from the egg, not as the sport of circumstances, but with the same innate necessity that causes the gastrula to succeed the blastula in ontogenesis?"

The principal points of view of the theory of Biogenesis are summarized by Hertwig in the concluding pages; they may be condensed thus:

1. "Since all organisms pass through the unicellular conditions in their development, all constant or essential characters by which species is distinguished from species must be contained in their simplest form, or, so to speak, reduced to their simplest expression in this. There are thus as many fundamentally different species of cells as there are different species of plants and animals."

2. The essential distinctions between these cells are not directly discernible. But from logical considerations we are forced to assume "that the cells possess a finer micellar organization exceeding our powers of observation, by virtue of which they are the bearers of the properties of the species," and that this substance, the idioplasm, makes up only a small part of the whole substance of the cell. "According to our theory it is contained in the nucleus."

3. "The cause of continuity in development is that each individual is the product of a cell possessing the same specific properties."

4. As to the causes of the development of the individual from the species-cell, the theory of Biogenesis postulates 'the increase of the species-cell and the correlative process of social union, division of labor and integration.'

5. The process of cleavage is a multiplication of the original cell, all products possessing the same fundamental organization.

6. "The aggregate takes on definite forms during its growth, which in any stage are the expression of: (1) the influence of innumerable external factors; but still more (2) of the endlessly complicated effects which the constantly increasing elementary units exercise on one another."

7. "Within the series of generations of persons, or between the separate ontogenies, the continuity of development is preserved by single cells freeing themselves from the aggregate of the species-cells and becoming the origin of a new process of development."

In conclusion, I cannot avoid criticising the name which the author has chosen for his theory of development. It is not in any sense

a theory of *Biogenesis*. We are told on page 236 that the name was given to express the idea 'that the origin of the complex organism is to be explained from the properties of an elementary being, the cell.' If only it did express this!

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Animal Intelligence. By WESLEY MILLS. New York, The Macmillan Co. 1898. Pp. x + 307.

The first fifty pages of Professor Mills' book are made up of certain theoretical discussions. The rest consists in the main of reprints from the *Transactions, Royal Society of Canada*, already familiar to those who follow the progress of animal psychology. In his theorizing Professor Mills refuses the moderate attitude of Lloyd Morgan, Wundt and other recent psychologists and reverts to a position comparable to that of Romanes. He even calls Lindsay's writings 'admirable.' Here is no place to refute his claims; it will suffice to say that he leaves the problem in the loose and unprofitable form of more or less 'intelligence' instead of resolving it into definite questions about the presence or absence of particular mental processes. Moreover, he wastes his energy on such straw men as the theory that all the actions of animals are due to instinct or that human minds were created especially of quite different stuff. One novelty in his discussion is the insistence that human conceit makes men underrate animals' capacities. When one thinks of the wide prevalence of animal-worship, of the reverent eulogies of instinct so common in books of the middle of this century, or of his own experience of present opinion about animals, this notion of Professor Mills seems extraordinarily perverse. I should say that we naturally tend to do quite the opposite, to interpret animals' acts by our own minds, and, when any strange act appears, to explain it in the most glorified way possible.

The observations which are recorded in the book concern the habits of squirrels, hibernation, and the early life of dogs, cats, rabbits, guinea-pigs, pigeons and chicks. Such records are of the greatest value, and to Professor Mills is due the credit of doing more of such work, I suppose, than any one else has yet done. The development of the sense-powers, the presence of instinctive reactions of various sorts, the correlation of physical growth with mental development, the formation of habits—data concerning all these are given. One could praise them unreservedly were it not for Professor Mills' habit of occasionally mixing up opinion with observation. On page 139, for instance, he says: "I notice that the precocious bitch acts towards the whip much as an *old dog* or a half-grown one often does. This is difficult to describe. The animal shows that it understands what its relations are, but seems to combine a sort of pleading with humor." The last sentence is a good record of Professor Mills' attitude toward animal psychology, but it is worthless as far as concerns the dog. In harmony with his general theory Professor Mills finds in these young animals signs of reasoning, a moral sense and a sense of humor. Many would interpret these signs very differently.

In closing I wish to say a little about the observational method of studying animal psychology. Without forgetting a single one from among its advantages, the fact remains that, unless you practice continuous observation from birth, you do not get complete control of the animal's experience. Actions which you observe in one hour out of the twenty-four may be due to experience acquired during the remaining twenty-three. The meaning of phenomena is also often dubious. Why then neglect specific experiments, even if you have to use unnatural surroundings? It would seem that if Professor Mills had used a part of his time in making crucial experiments to decide definite questions, he would at least have had a means of checking his other results. Finally, I would beg that anyone who is studying animal psychology to throw light on the human mind, to leave the poor dogs and cats and guinea-pigs and above all the favorite chicken, to feel their feelings in peace and devote himself to the monkeys. Since Hubrecht has shown how early the primate stock split off, it seems far-fetched to call a dog-mind and cat-mind an ancestor in any sense of the human.

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